Table of Contents

Foreword

This publication, *Keys to Soil Taxonomy*, serves two purposes. It provides the taxonomic keys necessary for the classification of soils according to Soil Taxonomy in a form that can be used easily in the field, and it also acquaints users of Soil Taxonomy with recent changes in the classification system. This volume includes all revisions of the keys that have so far been approved, replacing the original keys in *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys* (1975), the work on which this abridged version, first published in 1983, is based. We plan to continue issuing updated editions of *Keys to Soil Taxonomy* as changes warrant a new edition. Plans are under way to republish *Soil Taxonomy* in its entirety in 1998.

This publication incorporates all amendments approved to date and published in National Soil Taxonomy Handbook (NSTH) Issues 1-18. It includes the recommendations of the International Committee on Low Activity Clays (NSTH Issue #8), the International Committee on Oxisols (NSTH Issue #11), the International Committee on Andisols (NSTH Issue #13), the International Committee on Vertisols (NSTH Issue #16), the International Committee on Aquic Moisture Regime (NSTH Issue #16), the International Committee on Spodosols (NSTH Issue #16), the International Committee on Aridisols (NSTH Issue #17), and the International Committee on Families (NSTH #18). Editorial changes have been made throughout the *Keys to Soil Taxonomy* to make grammatical corrections and clarify the intent of the criteria.

The keys reproduced here were extracted from a computerized copy of *Soil Taxonomy*, which is maintained in complete, up-to-date form.

The authors of *Keys to Soil Taxonomy* are identified as "Soil Survey Staff." This term is meant to include all the soil classifiers in the National Cooperative Soil Survey program and in the international community who have made significant contributions to the improvement of Soil Taxonomy.

RICHARD W. ARNOLD
Director, Soil Survey Division
Soil Conservation Service
1996

A surface mantle of new material, as defined here, is largely unaltered, at least in the lower part. It may have a diagnostic surface horizon (epipedon) and/or a cambic horizon, but has no other diagnostic subsurface horizons, all defined later. However, there remains a layer 7.5 cm or more thick that fails the requirements for all diagnostic horizons, as defined later, overlying a horizon sequence that can be clearly identified as the solum of a buried soil in at least half of each pedon. This layer must also fail color and structure requirements of the cambic horizon if sandy. The recognition of a surface mantle should not be based only on studies of associated soils.

The depth to which an epipedon must be buried to be considered part of a buried soil is defined above (Chapter 1).

A recent alluvial or eolian deposit that retains fine stratification, or an Ap horizon directly underlain by such stratified material, is not included in the concept of the epipedon because time has not been sufficient for soil-forming processes to erase these transient marks of deposition and for diagnostic and accessory properties to develop.

An epipedon is not the same as an A horizon; it may include part or all of the illuvial B horizon if the darkening by organic matter extends from the soil surface into or through the B horizon. To avoid changes in the classification of a soil as a result of plowing, the properties of the epipedon, except for structure, should be determined after mixing the surface soil to a depth of 18 cm, or the whole soil if its depth to bedrock is less than 18 cm.

Anthropic epipedon (Gr. anthropikos, human)

The anthropic epipedon has some evidence of disturbance by humans and conforms to all the requirements for the mollic epipedon (defined below) except either (1) the limits on acid-soluble P_2O_5, with or without the base saturation, or (2) the duration of available moisture. Additional data on anthropic epipedons from several parts of the world may permit future improvements in this definition.

Histic epipedon (Gr. histos, tissue)

The histic epipedon is normally at the soil surface, although it may be buried. It consists of organic soil material (peat or muck) if the soil has not been plowed. If the soil has been plowed, the epipedon normally has a high content of organic matter that results from mixing organic soil material with some mineral material. The histic epipedon either has aquic conditions for some time in most years or has been artificially drained.

The histic epipedon can thus be defined as a layer (one or more horizons) that has aquic conditions for some time in most years (or is artificially drained), and either:

1. Consists of organic soil material which:

   a. Is 20 to 60 cm thick and either contains 75 percent or more (by volume) sphagnum fibers or has a bulk density, moist, of less than 0.1 g/cm^3; or

b. Is 20 to 40 cm thick and has an organic-carbon content (by weight) of:

(1) 18 percent or more if the mineral fraction contains 60 percent or more clay; or

(2) 12 percent or more if the mineral fraction contains no clay; or

(3) 12 + (clay percentage multiplied by 0.1) percent or more if the mineral fraction contains less than 60 percent clay; or

2. Is an Ap horizon which, when mixed to a depth of 25 cm, has an organic-carbon content (by weight) of:

a. 16 percent or more if the mineral fraction contains 60 percent or more clay; or

b. 8 percent or more if the mineral fraction contains no clay; or

c. 8 + (clay percentage divided by 7.5) percent or more if the mineral fraction contains less than 60 percent clay.

Most histic epipedons consist of organic soil material as defined below. Item 2 provides for histic epipedons that are Ap horizons consisting of mineral soil material.

Melanic epipedon (Gr. melas, melan-, black)

The melanic epipedon is a thick black horizon at or near the soil surface which contains high concentrations of organic carbon, usually associated with short-range-order minerals or aluminum-humus complexes. The intense black color is attributed to the accumulation of organic matter from which "Type A" humic acids are extracted. This organic matter is thought to result from large amounts of root residues supplied by a gramineous vegetation, and can be distinguished from organic matter formed under forest vegetation by the melanic index (Honna et al., 1988).[2]

The suite of secondary minerals is usually dominated by allophane, and the soil material has a low bulk density and a high anion adsorption capacity.

[2] Honna,T. S. Yamammoto and K Matsui. 1988. A simple procedure to determine melanic index. See ICOMAND Circular Letter No. 10, pp. 76-77.

a. 10 cm or more if the epipedon is directly above a densic, lithic, or paralithic contact, a petrocalcic horizon, or a duripan; or

b. 25 cm or more if either

(1) The texture of the epipedon is loamy fine sand or coarser throughout; or

(2) There are no underlying diagnostic horizons (defined below) and the organic-carbon content of the underlying materials decreases irregularly with increasing depth (as in recent alluvial deposits); or

c. 25 cm or more if the epipedon is finer than loamy fine sand and if all of the following are 75 cm or more below the mineral soil surface:

(1) The upper boundary of any pedogenic lime that is present as filaments, soft coatings, or soft nodules; and

(2) The lower boundary of any argillic, cambic, natric, oxic, or spodic horizon (defined below); and

(3) The upper boundary of any petrocalcic horizon, duripan, or fragipan; or

d. If the epipedon is loamy or clayey, 18 cm or more, and one third or more of the total thickness between the top of the epipedon and the shallowest of any features listed in (c) that are less than 75 cm below the mineral soil surface; or

e. 18 cm or more if none of the above conditions apply.

6. The epipedon has less than 250 parts per million (ppm) of P_2O_5 soluble in 1 percent citric acid, or it does not have a regular decrease in the amounts of P_2O_5 with increasing depth below the epipedon, or there are phosphate nodules within the epipedon. This restriction is made to eliminate plow layers of very old arable soils and kitchen middens which, under use, have acquired the properties of a mollic epipedon, while including the epipedon of a soil developed in highly phosphatic parent material.

7. If the soil is not irrigated, some part of the epipedon is moist 3 months or more (cumulative) per year in 8 or more out of 10 years during times when the soil temperature at a depth of 50 cm is 5°C or higher.

The plaggen epipedon normally shows spade marks throughout its depth and also remnants of thin stratified beds of sand that were probably produced on the soil surface by beating rains and were later buried by spading.

Umbric epipedon (L. umbra, shade, hence dark)

Requirements for an umbric epipedon with regard to color, organic-carbon and phosphorus content, consistence, structure, *n* value, and thickness are the same as those for the mollic epipedon. The umbric epipedon includes those thick, dark-colored surface horizons that have a base saturation of less than 50 percent (by NH_4OAc). It should be noted that the restriction against an epipedon that is hard, very hard, or harder and massive when dry is applied only to those epipedons that become dry. If the epipedon is always moist, there is no restriction on its consistence or structure when dry. It should also be noted that some plaggen epipedons meet all these requirements but also show evidence of a gradual addition of materials during cultivation, whereas the umbric epipedon does not have the artifacts, spade marks, and raised surfaces that are characteristic of the plaggen epipedon.

Diagnostic Subsurface Horizons

The horizons discussed in this section form below the surface of the soil, although in some areas they form directly below a layer of leaf litter. They may be exposed at the surface by truncation of the soil. Some of these horizons are generally regarded as B horizons, some are considered B horizons by many but not all pedologists, while others are generally regarded as parts of the A horizon.

Agric horizon

The agric (L. *ager*, field) horizon is an illuvial horizon which has formed under cultivation and contains significant amounts of illuvial silt, clay, and humus. After a soil has been cultivated for a long time, changes in the horizon directly below the plow layer become apparent and cannot be ignored in classifying the soil. The large pores in the plow layer and the absence of vegetation immediately after plowing permit a turbulent flow of muddy water to the base of the plow layer. Here the water can enter wormholes or fine cracks between peds, and the suspended materials are deposited as the water is withdrawn into capillary pores. The worm channels, root channels, and surfaces of peds in the horizon underlying the plow layer become coated with a dark-colored mixture of organic matter, silt, and clay. The accumulations on the sides of wormholes become thick and can eventually fill them. If worms are scarce, the accumulations may take the form of lamellae that range in thickness from a few millimeters to about 1 cm. The lamellae and the coatings on the sides of wormholes always have a lower color value and chroma than the soil matrix.

The agric horizon can have somewhat different forms in different climates if there are differences in soil fauna. In a humid temperate climate where soils have a udic moisture regime and a mesic soil temperature regime (defined below), earthworms can become abundant. If there are earthworm holes which, including their coatings, constitute 5 percent or more (by volume) of the horizon and if the coatings are 2 mm or more thick and have a color value, moist, of 4 or less and a chroma of 2 or less, the horizon is an agric horizon. After long cultivation, the content of organic matter in the agric horizon is not likely to be high, but the carbon-nitrogen ratio is low (usually less than 8). The pH value of the agric horizon is close to neutral (6 to 6.5).

In a Mediterranean climate where soils have a xeric soil moisture regime (defined below), earthworms are less common and the illuvial materials accumulate as lamellae directly below the Ap horizon. If these lamellae are 5 mm or more thick, have a color value, moist, of 4 or less and a chroma of 2 or less, and constitute 5 percent or more (by volume) of a horizon 10 cm or more thick, this horizon is an agric horizon.

Albic horizon

The albic (L. *albus*, white) horizon is an eluvial horizon 1.0 cm or more thick which contains 85 percent or more (by volume) albic materials (defined below). It usually occurs below an A horizon but may be at the mineral soil surface. Under the albic horizon there is usually an argillic, cambic, kandic, natric, or spodic horizon or a fragipan (defined below). The albic horizon may lie between a spodic horizon and either a fragipan or an argillic horizon; or it may be between an argillic or a kandic horizon and a fragipan. It may lie between a mollic epipedon and an argillic or natric horizon, or between a cambic horizon and an argillic, kandic, or natric horizon or a fragipan. The albic horizon may separate horizons which, if together, would meet the requirements for a mollic epipedon. It may separate lamellae that together meet the requirements for an argillic horizon; these lamellae are not considered to be part of the albic horizon.

In some soils the horizon underlying the albic horizon is too sandy or too weakly developed to have the levels of accumulation required for an argillic, a kandic, a natric, or a spodic horizon. Some soils have, directly below the albic horizon, either a densic, lithic, or paralithic contact, or another relatively impervious layer that produces a perched water table with stagnant or moving water.

Argillic horizon

An argillic (L. *argilla*, clay) horizon is an illuvial horizon which contains significant accumulations of illuviated layer-lattice silicate clays. It must have formed below an eluvial horizon but may be found at the surface of a partially truncated soil. The following characteristics are used for its identification:

1. If there is a lithologic discontinuity between the overlying eluvial horizon and the argillic horizon or if it is overlain only by a plow layer, clay films are required only in some part of the argillic horizon, either in some fine pores or, if peds are present, on some vertical and horizontal surfaces of peds. Either some part of the horizon is shown in thin section to have 1 percent or more oriented clay bodies, or the ratio of fine clay to total clay in the argillic horizon is higher than in the overlying or the underlying horizon.

2. If an eluvial horizon remains and there is no lithologic discontinuity between it and the underlying argillic horizon, the argillic horizon contains, within 30 cm of an eluvial horizon, higher percentages of total clay and fine clay than the eluvial horizon, as follows:

    a. If any part of the overlying eluvial horizon has less than 15 percent total clay in its fine-earth fraction, the total clay content in the argillic horizon is 3 percent or more (absolute) higher than in the eluvial horizon (e.g., 13 percent versus 10 percent). The ratio of fine clay to total clay in the argillic horizon is normally one third or more higher than in the overlying eluvial or in the underlying horizon.

    b. If the overlying eluvial horizon has 15 to 40 percent total clay in its fine-earth fraction, the total clay content in the argillic horizon is 20 percent or more (relative) higher than in the eluvial horizon (e.g., 24 percent versus 20 percent). The ratio of fine clay to total clay in the argillic horizon is normally one third or more higher than in the eluvial horizon.

    c. If the eluvial horizon has 40 to 60 percent total clay in the fine-earth fraction, the total clay content in the argillic horizon is 8 percent or

a. Aquic conditions for some time in most years (or artificial drainage), and both of the following:

(1) Within 50 cm of the mineral soil surface, either on faces of peds, or in the matrix if peds are absent, 50 percent or more chroma as follows:

(a) Two or less, and redox concentrations; or

(b) Zero, and a color value, moist, of 3 or less; or

(c) One or less, and a color value, moist, of 4 or more; and

(2) One or more of the following properties:

(a) A regular decrease in the amount of organic carbon with increasing depth, and an organic-carbon content of less than 0.2 percent either at a depth of 125 cm below the mineral soil surface, or directly above a sandy-skeletal substratum at a depth of less than 125 cm; or

(b) Cracks that open and close in most years and are 1 cm or more wide at a depth of 50 cm below the mineral soil surface; or

(c) Permafrost at some depth; or

(d) A histic epipedon consisting of mineral soil materials, or a mollic or an umbric epipedon; or

b. Either no aquic conditions (or artificial drainage), or colors different from those defined in 3.a, or both, and one or more of the following:

(1) A higher chroma, redder hue, or higher clay content than in the underlying horizon; or

(2) Evidence of removal of carbonates; particularly, less carbonate than in the underlying k horizon (if all coarse fragments in the k horizon are completely coated with lime, some in the cambic horizon are partly free of coatings; if coarse fragments in the k horizon are

coated only on the underside, those in the cambic horizon are free of coatings); or

(3) If carbonates are absent in the parent material and in the dust that falls on the soil, the requirement of evidence of alteration is satisfied by the presence of soil structure and absence of rock structure; and

4. Properties that do not meet the requirements for an argillic, a kandic, an oxic, or a spodic horizon; and

5. No cementation or induration and no brittle consistence when moist; and

6. A lower boundary at a depth of 25 cm or more from the mineral soil surface, unless the soil temperature regime is cryic or pergelic.

Duripan

The duripan (L. *durus*, hard; meaning hardpan) is a subsurface horizon that is cemented by illuvial silica to the degree that less than 50 percent of the volume of air-dry fragments slake in water or during prolonged soaking in acid (HCl). Duripans vary in the degree of cementation by silica and, in addition, they commonly contain accessory cements, chiefly iron oxides and calcium carbonate.

Summary of properties

The duripan is a silica-cemented subsurface horizon with or without auxiliary cementing agents. A duripan can occur in conjunction with a petrocalcic horizon.

A duripan must meet all of the following requirements:

1. Is cemented or indurated in more than 50 percent of the volume of some horizon; and

2. Has evidence of accumulation of opal or other forms of silica as laminar capping, coatings, lenses, partly filled interstices, bridges between sand-size grains, or coatings on rock or pararock fragments; and

3. Less than 50 percent of the volume slakes in 1N HCl even during prolonged soaking, but more than 50 percent slakes in concentrated KOH, NaOH, or in alternating acid and alkali; and

4. Has lateral continuity such that roots cannot penetrate except along vertical fractures, which have a horizontal spacing of 10 cm or more.

Fragipan

A fragipan (modified from L. *fragilis*, brittle, and pan; meaning brittle pan) is an altered subsurface horizon, 15 cm or more thick, that restricts the entry of water and roots into the soil matrix. It may, but does not necessarily, underlie an argillic, cambic, albic, or spodic horizon. It is commonly within an argillic horizon, but some are within an albic horizon. The fragipan has strongly developed fragic properties (defined below). Commonly it has a relatively low content of organic matter and a high bulk density relative to the horizons above it. The fragipan has a hard or harder rupture resistance class, when dry. When moist, it has a brittle manner of failure in 60 percent or more of the volume. This is the tendency for a ped or clod to rupture suddenly rather than to undergo slow deformation when pressure is applied. Air dried fragments slake when submerged in water. Most fragipans have redoximorphic features, have evidence of translocation of clay, and are slowly or very slowly permeable to water. Some fragipans consist of albic materials (defined below).

Summary of properties

To be identified as a fragipan a layer must have all of the following characteristics:

1. The layer is 15 cm or more thick; *and*

2. It has evidence of pedogenesis within the horizon or, at a minimum, on the faces of structural units; *and*

3. It has very coarse prismatic, columnar, or blocky structure of any grade, has weak structure of any size, or is massive. Separations between structural units that allow roots to enter have an average spacing of 10 cm or more on the horizontal dimensions; *and*

4. Air-dry fragments of the natural soil fabric, 5 to 10 cm in diameter, from more than 50 percent of the horizon slake when they are submerged in water; *and*

5. It has, in 60 percent or more of the volume, a firm or firmer consistence, a brittle manner of failure at or near field capacity, and roots virtually absent.

3. Is 5 percent or more gypsum and is 1 percent or more by volume secondary visible gypsum; and

4. Has a product of thickness in centimeters multiplied by gypsum content percentage of 150 or more.

Thus, a horizon 30 cm thick that is 5 percent gypsum qualifies as a gypsic horizon if it is 1 percent or more by volume visible gypsum and is not cemented or indurated to such a degree that it meets the requirements of a petrogypsic horizon. The gypsum percentage can be calculated by multiplying the milliequivalents of gypsum per 100 g soil by the milliequivalent weight of $CaSO_4 \cdot 2H_2O$, which is 0.086.

Kandic horizon[5] (kand- modified from kandite)

The kandic horizon:

1. Is a vertically continuous subsurface horizon that underlies a coarser-textured surface horizon. The minimum thickness of the surface horizon is 18 cm after mixing, or 5 cm if the textural transition to the kandic horizon is abrupt and there is no densic, lithic, paralithic, or petroferric contact (defined below) within 50 cm of the mineral soil surface.

2. Has its upper boundary:

    a. At the point where the clay percentage in the fine-earth fraction, increasing with depth within a vertical distance of 15 cm or less, is either

        (1) 4 percent or more (absolute) higher than in the surface horizon if that horizon has less than 20 percent total clay in the fine-earth fraction; or

        (2) 20 percent or more (relative) higher than in the surface horizon if that horizon has 20 to 40 percent total clay in the fine-earth fraction; or

        (3) 8 percent or more (absolute) higher than in the surface horizon if that horizon has more than 40 percent total clay in the fine-earth fraction; and

[5] The kandic horizon and the kandi and kanhapli great groups of soils represent the work of the International Committee on the Classification of Low Activity Clays (ICOMLAC), chaired by Frank R. Moormann.

Natric horizon

The natric (NL. *natrium*, sodium) horizon is a special kind of argillic horizon. It has, in addition to the properties of the argillic horizon:

1. Either

   a. Columns, or less commonly, prisms in some (usually the upper) part, which may break to blocks; or

   b. Both blocky structure and eluvial materials, which contain uncoated silt or sand grains, and extend more than 2.5 cm into the horizon; and

2. Either

   a. An exchangeable sodium percentage (ESP) of 15 percent or more (or a sodium adsorption ratio, SAR, of 13 or more) in one or more subhorizons within 40 cm of its upper boundary; or

   b. More exchangeable magnesium plus sodium than calcium plus exchange acidity (at pH 8.2) in one or more subhorizons within 40 cm of its upper boundary, if the ESP is 15 or more (or the SAR is 13 or more) in one or more horizons within 200 cm of the mineral soil surface.

Ortstein

Ortstein is a cemented horizon that consists of spodic materials.

Ortstein has one of the following orientations:

1. As a relatively horizontal layer. This type of orientation tends to be root restrictive and occurs primarily in Aquods.

2. As vertical to irregular columns, tongues, pillars, or bridges. This orientation tends to be less root restrictive than the horizontal orientation. This type of orientation occurs primarily in Orthods.

3. As nodules. These may be remnants of one of the orientations listed above.

Ortstein is 25 mm or more thick and 50 percent or more (by volume) cemented. Continuous ortstein is 90 percent or more cemented and has lateral continuity such that roots cannot penetrate except along vertical fractures, which have a horizontal spacing of 10 cm or more.

Ortstein is differentiated from a placic horizon that is within spodic materials solely on thickness. Placic horizons within spodic materials are less than 25 mm thick and ortstein is 25 mm or more thick.

Summary of properties

Ortstein has all of the following:

1. Consists of spodic materials; and

2. Is in a layer that is 50 percent or more cemented; and

3. Is 25 mm or more thick.

Oxic horizon

The oxic (*oxic* modified from oxide) horizon is a mineral subsurface horizon of sandy loam or a finer particle size with low cation exchange capacity and low weatherable-mineral content. Its upper boundary is either 18 cm below the mineral soil surface or at the lower boundary of an Ap horizon, whichever is deeper, or at a greater depth where mineralogical and charge characteristics meet the requirements for the oxic horizon. Any increase in clay content at the upper boundary must be diffuse. The lower boundary of the oxic horizon is also defined by its mineralogical and charge requirements and may, in addition, be defined by the presence of saprolite with rock structure.

The oxic horizon does not have andic soil properties (defined below), and has all the following characteristics:

1. A thickness of 30 cm or more; and

2. A particle size of sandy loam or finer in the fine-earth fraction; and

3. Less than 10 percent weatherable minerals in the 50-to-200-micron fraction; and

4. Rock structure in less than 5 percent of its volume, or sesquioxide coatings on lithorelics containing weatherable minerals; and

5. A diffuse upper particle-size boundary, i.e., within a vertical distance of 15 cm, a clay increase with depth of:

    a. Less than 4 percent (absolute) in its fine-earth fraction if that of the surface horizon contains less than 20 percent clay; or

b. Less than 20 percent (relative) in its fine-earth fraction if that of the surface horizon contains 20 to 40 percent clay; or

c. Less than 8 percent (absolute) in its fine-earth fraction if that of the surface horizon contains 40 percent or more clay); and

6. A CEC of 16 cmol(+) or less per kg clay[7] (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+) or less per kg clay (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al).

Petrocalcic horizon

The petrocalcic (Gr. *petra*, rock) horizon is an illuvial horizon in which secondary calcium carbonate or other carbonates have accumulated to the extent that the horizon is cemented or indurated.

The petrocalcic horizon is indurated or cemented throughout each pedon by calcium carbonate or, less commonly, by calcium and magnesium carbonate, with or without accessory silica, to such a degree that dry fragments do not slake in water and roots cannot enter except in cracks that have a horizontal spacing of 10 cm or more. If soaked in acid, cementation of the petrocalcic horizon is destroyed in half or more of its lateral extent in each pedon. The horizon is commonly massive or platy, very hard or harder and very firm or firmer when moist. Its saturated hydraulic conductivity is commonly moderately low to very low unless the horizon is fractured.

A laminar cap may be present but is not required. If one is present, carbonates normally constitute half or more by weight of the laminar horizon. Gravel, sand, and silt grains have been separated by the crystallization of carbonates in at least parts of the laminar subhorizon.

A petrocalcic horizon must meet the following requirements:

1. It is cemented or indurated by carbonates with or without silica or other cementing agents; and

2. Has a lateral continuity such that roots cannot penetrate except along vertical fractures, which have a horizontal spacing of 10 cm or more; and

[7] The percentage of clay is either measured by the pipette method, or estimated to be 3 times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

3. Has a thickness of:

   a. 10 cm or more; or

   b. 1 cm or more if it consists of a laminar capping directly underlain by bedrock.

Petrogypsic horizon

The petrogypsic horizon is an illuvial horizon 10 cm or more thick in which secondary gypsum has accumulated to the extent that the horizon is cemented or indurated.

A petrogypsic horizon must meet the following requirements:

1. It is cemented or indurated by gypsum with or without other cementing agents; and

2. Has a lateral continuity such that roots cannot penetrate except along vertical fractures, which have a horizontal spacing of 10 cm or more; and

3. Has a thickness of 10 cm or more; and

4. Is 5 percent or more gypsum and the product of the thickness in centimeters multiplied by the gypsum content percentage is 150 or more.

Placic horizon

The placic (Gr. *plax, plak-*, flat stone) horizon is a thin, black to dark reddish pan that is cemented either by iron, or iron and manganese, or an iron-organic-matter complex. It is generally between 2 and 10 mm thick, but may be as thin as 1 mm or, in spots, up to 25 mm thick. It is often associated with stratification in parent materials. The placic horizon is in the solum, commonly within 50 cm of the mineral soil surface, and roughly parallel with it. It has a pronounced wavy or even convoluted form. Normally it occurs as a single pan rather than as multiple sheets (one underlying another), but it may be bifurcated. It is a barrier to water and roots.

If cemented by iron, the pan is strong brown to dark reddish brown; if cemented by iron and manganese or by iron-organic-matter complexes, it is black or reddish black. A single pan may contain two or more layers that are cemented by different agents; commonly iron-organic-matter complexes are found in the upper part of the pan.

Unless its thickness is minimal, identification of a placic horizon is seldom difficult because the hard, brittle pan differs so much from the material in which it occurs and is so close to the mineral soil surface. Analyses of placic horizons show that they contain between 1 and more than 10 percent organic carbon. The presence of organic carbon and the shape and position of the placic horizon distinguish it from the ironstone sheets that may form where water hangs, or moves laterally, at a lithologic discontinuity.

Salic horizon

A salic (L. *sal*, salt) horizon is a horizon of accumulation of salts which are more soluble than gypsum in cold water.

A salic horizon is 15 cm or more thick and has for 90 consecutive days or more per year, in 6 or more years out of 10:

1. An electrical conductivity (EC) equal to or greater than 30 dS/m in a 1:1 soil : water extract; and

2. The product of the EC in dS/m and thickness in cm equal 900 or more.

Sombric horizon

The sombric (Sp. *sombra*, shade, hence dark) horizon is a subsurface horizon of mineral soils which has formed under free drainage. It contains illuvial humus that is neither associated with aluminum, as is the humus in the spodic horizon, nor dispersed by sodium, as is common in the natric horizon. Consequently the sombric horizon does not have the high cation-exchange capacity in its clay that characterizes a spodic horizon, and it does not have the high base saturation of a natric horizon. It does not underlie an albic horizon.

Sombric horizons are thought to be restricted to the cool, moist soils of high plateaus and mountains in tropical or subtropical regions. Because of strong leaching, their base saturation is low (less than 50 percent by NH_4OAc).

The sombric horizon has a lower color value or chroma, or both, than the overlying horizon and commonly contains more organic matter. It may have formed in an argillic, a cambic, or an oxic horizon. If peds are present, the dark colors are most pronounced on surfaces of peds.

In the field, a sombric horizon is easily mistaken for a buried A horizon. It can be distinguished from some buried epipedons by lateral tracing. In thin sections, the organic matter of a sombric horizon appears more concentrated on peds and in pores rather than uniformly dispersed through the matrix.

doubles within a vertical distance of 7.5 cm or less. If the clay content of the fine-earth fraction of the ochric epipedon or albic horizon is 20 percent or more, there is an increase of 20 percent or more (absolute) within a vertical distance of 7.5 cm or less (e.g., an increase from 22 to 42 percent), and the clay content in some part of the argillic horizon is two times or more the amount contained in the overlying horizon.

Normally there is no transitional horizon between an ochric epipedon or albic horizon and an argillic horizon, or it is too thin to be sampled. Some soils, however, have a glossic horizon or interfingering of albic materials (defined below) in parts of the argillic horizon. The upper boundary of such a horizon is irregular or even discontinuous. Sampling this mixture as a single horizon might create the impression of a relatively thick transitional horizon, whereas the thickness of the actual transition at the contact may be no more than 1 mm.

Albic materials (L. albus, white)

Albic materials are soil materials with a color that is largely determined by the color of primary sand and silt particles, rather than by the color of their coatings. The definition implies that clay and/or free iron oxides have been removed from the materials, or the oxides have been segregated to such an extent that the color of the materials is largely determined by the color of the primary particles.

Albic materials have one of the following colors:

1. A chroma of 2 or less, and either:

    a. A color value, moist, of 3 or more, and a color value, dry, of 6 or more; or

    b. A color value, moist, of 4 or more, and a color value, dry, of 5 or more; or

2. A chroma of 3 or less, and

    a. A color value, moist, of 6 or more; or

    b. A color value, dry, of 7 or more; or

    c. A chroma that is controlled by the color of uncoated grains of silt or sand, a hue of 5YR or redder, and color values listed in 1.a or 1.b above.

Relatively unaltered layers of light-colored sand, volcanic ash, or other materials deposited by wind or water are not considered albic materials, although they may have the same color and apparent morphology. These deposits are parent materials which have not had clay and/or free iron removed and do not overlie an illuvial horizon or other soil horizon except a buried soil. Light-colored krotovina or filled root channels should only be considered albic materials if they have no fine stratifications or lamellae, if any sealing along krotovina walls has been destroyed, and if these intrusions have, after deposition, been leached of free iron oxides and/or clay.

Andic soil properties (Japn. ando, dark soil)

Andic soil properties result mainly from the presence, in soils, of significant amounts of allophane, imogolite, ferrihydrite or aluminum-humus complexes.

The concept of Andisols includes weakly weathered soils with much volcanic glass as well as more strongly weathered soils rich in short-range-order minerals. Hence the content of volcanic glass is one of the characteristics used in defining andic soil properties.

Volcanic glass is defined as optically isotropic translucent glass or pumice of any color, including glassy aggregates and glass coatings on other mineral grains. Composite grains must have at least 50 percent by volume of volcanic glass to be counted as volcanic glass.

Most horizons that have andic soil properties consist of mineral soil materials but some consist of organic soil materials but they must have less than 25 percent organic carbon.

To be recognized as having andic soil properties, soil materials must contain less than 25 percent (by weight) organic carbon and meet one or both of the following requirements:

1. In the fine-earth fraction, all of the following:

   a. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 2.0 percent or more, and

   b. A bulk density, measured at 33 kPa water retention, of 0.90 g/cm^3 or less, and

   c. A phosphate retention[8] of 85 percent or more; or

[8] Blakemore, L.C., P.L. Searle, and B.K. Daly. 1987. Methods for chemical analysis of soils. NZ Soil Bureau Scientific Report 80. pp. 44-45.

2. In the fine-earth fraction, a phosphate retention of 25 percent or more, 30 percent or more particles of 0.02 to 2.0 mm, and one of the following:

a. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.40 or more and, in the 0.02-to-2.0-mm fraction, 30 percent or more volcanic glass; or

b. Aluminum plus 1/2 iron percentages (by ammo nium oxalate) totaling 2.0 or more and, in the 0.02-to-2.0-mm fraction, 5 percent or more volcanic glass; or

c. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling between 0.40 and 2.0 and, in the 0.02-to-2.0-mm fraction, enough volcanic glass so that the glass percentage, when plotted against the value obtained by adding aluminum plus 1/2 iron percentages in the fine-earth fraction, falls within the shaded area of Figure 1.

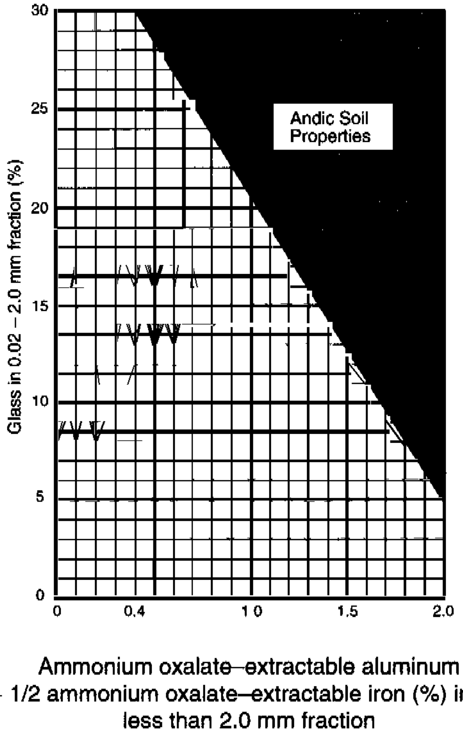

Figure 1— Soils that plot in the shaded area have Andix soil properties if the less-than-2.0 mm fraction has phosphate retention of more than 25 percent and the 0.02-to 2.0 mm fraction is at least 30 percent of the less-than2.0 mm fraction.

Aquic conditions[9] (L. aqua, water)

Soils with aquic conditions are those which currently experience continuous or periodic saturation and reduction. The presence of these conditions is indicated by redoximorphic features (defined below) and can be verified, except in artificially drained soils[10] by measuring saturation and reduction.

Elements of aquic conditions:

1. Saturation is characterized by zero or positive pressure in the soil-water and can generally be determined by observing free water in an unlined auger hole. However, problems may arise in clayey soils with peds, where an unlined auger hole may fill with water flowing along faces of peds while the soil matrix is and remains unsaturated (bypass flow). Such free water may incorrectly suggest the presence of a water table, while the actual water table occurs at greater depth. Use of well-sealed piezometers or tensiometers is therefore recommended for measuring saturation. Problems may, however, still occur if water runs into pyrometer slits near the bottom of the pyrometer hole or if tensiometers with slowly reacting manometers are used. The first problem can be overcome by using piezometers with smaller slits, and the second by using transducer tensiometry, which reacts faster than manometers. Soils are considered wet if they have pressure heads greater than -1 kPa. Only macropores such as cracks between peds or channels are then filled with air, while the soil matrix is usually still saturated. Obviously, exact measurements of the wet state can only be obtained with tensiometers. For operational purposes, the use of piezometers is recommended as a standard method.

   The duration of saturation required for creating aquic conditions is variable, depending on the soil environment, and is not specified.

---

[9] The term *aquic conditions* was introduced, and other changes were made throughout *Soil Taxonomy*, in 1992 as a result of recommendations submitted to NRCS by the Internaitonal Committee on Aquic Moisture Regime (ICOMAQ), which was established in 1982 and chaired initially by Frank Moormann, then by Johan Bouma since 1985.

[10] Artificial drainage is defined here as removal of free water from soils having aquic conditions by surface mounding, ditches, or subsurface tiles to the extent that watertable levels are changed significantly in connection with specific types of land use. In the *Keys*, artificially drained soils are included with soils that have aquic conditions.

presence of reduced iron ions. Use of a,a'-dipyridyl in a 10-percent acetic-acid solution is not recommended because the acid is likely to change soil conditions, for example by dissolving $CaCO_3$.

The duration of reduction required for creating aquic conditions is not specified.

3. Redoximorphic features associated with wetness result from the reduction and oxidation of iron and manganese compounds in the soil after saturation with water and desaturation, respectively. The reduced iron and manganese ions are mobile and may be transported by water as it moves through the soil. Certain redox patterns occur as a function of the patterns in which the ion-carrying water moves through the soil, and of the location of aerated zones in the soil. Redox patterns are also affected by the fact that manganese is reduced more rapidly than iron, while iron oxidizes more rapidly upon aeration. Characteristic color patterns are created by these processes. The reduced iron and manganese ions may be removed from a soil if vertical or lateral fluxes of water occur, in which case there is no iron or manganese precipitation in that soil. Wherever the iron and manganese is oxidized and precipitated, it forms either soft masses or hard concretions or nodules. Movement of iron and manganese as a result of redox processes in a soil may result in redoximorphic features that are defined as follows:

   a. Redox concentrations.—These are zones of apparent accumulation of Fe-Mn oxides, including:

      (1) Nodules and concretions, ie., cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal organization. A concretion typically has concentric layers that are visible to the naked eye. Nodules do not have visible organized internal structure. Boundaries commonly are diffuse if formed *in situ* and sharp after pedoturbation;

      (2) Masses are noncemented concentrations of substances within the matrix; and

      (3) Pore linings, i.e., zones of accumulation along pores which may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.

b. Redox depletions.—These are zones of low chroma (2 or less) where either Fe-Mn oxides alone or both Fe-Mn oxides and clay have been stripped out, including:

(1) Iron depletions, i.e., zones which contain low amounts of Fe and Mn oxides but have a clay content similar to that of the adjacent matrix (often referred to as albans or neoalbans); and

(2) Clay depletions, i.e., zones which contain low amounts of Fe, Mn, and clay (often referred to as silt coatings or skeletans).

c. Reduced matrix.—This is a soil matrix which has a low chroma *in situ*, but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air.

d. In soils that have no visible redoximorphic features, a positive reaction to an a,a'-dipyridyl solution satisfies the requirement for redoximorphic features.

Field experience indicates that it is not possible to define a specific set of redoximorphic features that is uniquely characteristic of all the taxa in one particular category. Therefore color patterns that are unique to specific taxa are referenced in the keys.

<u>Anthraquic conditions</u> represent a special kind of aquic conditions which occur in soils that are cultivated and irrigated. Soils with anthraquic conditions must meet the requirements for aquic conditions and in addition have both of the following:

a. A tilled surface layer and a directly underlying slowly permeable layer which have, for three months or more per year in most years, both

(1) Saturation and reduction; and

(2) A chroma of 2 or less in the matrix; and

b. A subsurface horizon with one or more of the following:

(1) Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less in macropores; or

(2) Redox concentrations of iron; or

(3) Two times or more the amount of iron (by dithionite citrate) contained in the tilled surface layer.

Coefficient of linear extensibility (COLE)

The coefficient of linear extensibility (COLE) is the ratio of the difference between moist length and dry length of a clod, to its dry length. It is $(Lm - Ld)/Ld$, where Lm is the length at 33 kPa tension and Ld is the length when dry. COLE can be calculated from the differences in bulk density of the clod when moist and when dry. An estimate of COLE can be calculated in the field by measuring the distance between two pins in a clod of undisturbed soil at field capacity and again after the clod has dried. COLE does not apply if the shrinkage is irreversible.

Densic contact

A densic contact (L. *densus*, thick) is a contact between soil and densic materials (defined below) that has no cracks or the spacing of cracks that roots can enter is 10 cm or more. It differs from both the *lithic contact* and the *paralithic contact* in that air dried fragments of the material forming a densic contact slake when submerged in water.

Densic materials

Densic materials are relatively unaltered (do not meet requirements for any other named diagnostic horizons nor any other diagnostic soil characteristic) materials that have a non-cemented rupture resistance class. The bulk density or the organization is such that roots cannot enter except in cracks. These are mostly earthy materials such as till, volcanic mudflows, and some mechanically compacted materials such as mine spoils. Some non-cemented rocks can also be densic materials, if they are dense or resistant enough to prevent roots from entering except in cracks.

Densic materials have at their upper boundary a *densic contact* if the it has no cracks or the spacing of cracks that roots can enter is 10 cm or more. Densic materials can be used to differentiate soil series if the materials are within the series control section (defined below).

Durinodes (L. durus, hard; nodus, knot)

Durinodes are weakly cemented to indurated nodules. The cement is SiO_2, presumably opal and microcrystalline forms of silica. It breaks down in hot concentrated KOH after treatment with HCl to remove carbonates, but does not break down with concentrated HCl alone. Dry durinodes do not slake appreciably in water, but prolonged soaking can result in spalling of very thin platelets and in some slaking. Durinodes are firm or very firm; they are brittle when wet, both before and after treatment with acid; and they are disconnected and have a diameter of 1 cm or more. Most durinodes are roughly concentric when viewed in cross section, and concentric stringers of opal may be visible under a hand lens.

Fragic Soil Properties

Fragic soil properties are similar to the essential properties of the *fragipan*. They have neither the layer thickness nor volume requirements of the fragipan. Fragic soil properties are in subsurface horizons, although they can be at or near the surface in truncated soils. Aggregates with fragic soil properties have a firm or firmer consistence and a brittle manner of failure when soil water is at or near field capacity. Air-dry fragments of the natural fabric, 5 to 10 cm in diameter slake when they are submerged in water. Aggregates with fragic soil properties have evidence of pedogenesis, including one or more of the following: Oriented clay within the matrix or on faces of peds; Redoximorphic features within the matrix or on faces of peds; Strong or moderate soil structure; And coatings of albic materials or uncoated silt and sand grains on faces of peds or in seams. Peds with these properties are considered to have fragic soil properties regardless of whether the density and brittleness are pedogenic or not.

Soil aggregates with fragic soil properties must:

1. Have evidence of pedogenesis within the aggregates or at a minimum, on the faces of the aggregates; *and*

2. Slake when air-dry fragments of the natural fabric, 5 to 10 cm in diameter, are submerged in water; *and*

3. Have a firm or firmer consistence and a brittle manner of failure when soil water is at or near field capacity; *and*

4. Restrict the entry of roots into the matrix when soil water is at or near field capacity.

Identifiable Secondary Carbonates

Identifiable secondary carbonates is a term used in the definitions of a number of taxa. It refers to translocated authigenic calcium carbonate that has been precipitated in place from the soil solution rather than inherited from a soil parent material such as a calcareous loess or till.

Identifiable secondary carbonates may either disrupt the soil structure or fabric to form masses, nodules, concretions, or spheroidal aggregates (white eyes) that are soft and powdery when dry; or it may be present as coatings in pores, on structural faces, or on the undersides of rock or pararock fragments. If present as coatings, it covers a significant part of the surfaces. Commonly, it coats all of them to a thickness of 1 mm or more; but if little calcium carbonate is present in the soil, the surfaces may be only partially coated. The coatings must be thick enough to be visible when moist. In some horizons with much calcium carbonate the entire horizon is colored by secondary carbonates.

The filaments (pseudomycelia) commonly seen in a dry calcareous horizon are within the meaning of identifiable secondary carbonates, if the filaments are thick enough to be visible when the soil is moist. Filaments commonly branch on structural faces.

Interfingering of albic materials

The term *interfingering of albic materials* means albic materials that penetrate 5 cm or more into an underlying argillic or natric horizon along vertical and, to a lesser degree, horizontal faces of peds. There need not be a continuous overlying albic horizon. The albic materials constitute less than 15 percent of the layer which they penetrate, but they form continuous skeletans (ped coatings of clean silt or sand defined by Brewer, 1964) 1 mm or more thick on the vertical ped faces, which means a total width of 2 mm or more between abutting peds. Because quartz is such a common constituent of silt and sand, these skeletans are usually light gray when moist and nearly white when dry, but their color is determined in large part by the color of the sand or silt fraction.

Interfingering of albic materials is recognized if albic materials:

1. Penetrate 5 cm or more into an underlying argillic or natric horizon; and

2. Are 2 mm or more thick between vertical faces of abutting peds; and

3. Constitute less than 15 percent (by volume) of the layer which they penetrate.

Lamellae

A lamella is an illuvial horizon less than 7.5 cm thick. Each lamella contains an accumulation of oriented silicate clay on or bridging the sand and silt grains (and coarse fragments if any are present). Each lamella is required to have more silicate clay than the overlying eluvial horizon.

Lamellae occur in a vertical series of 2 or more and each lamella must have an overlying eluvial horizon. (An eluvial horizon is not required above the upper most lamella if the soil is truncated.)

Lamellae may meet the requirements of either a cambic or an argillic horizon. A single lamella is a cambic horizon if the texture is very fine sand or loamy very fine sand or finer. A combination of two or more lamellae will meet the requirements of an argillic horizon if there is 15 cm or more cumulative total thickness of lamellae that are 0.5 cm or more thick and that have a clay content of either;

1. Three percent or more (absolute) higher than in the overlying eluvial horizon (e.g. 13 percent versus 10 percent) if any part of the eluvial horizon has less than 15 percent clay in the fine earth fraction or,

2. Twenty percent or more (relative) higher than in the overlying eluvial horizon (e.g. 24 percent versus 20 percent) if all parts of the eluvial horizon have more than 15 percent clay in the fine earth fraction.

Linear extensibility (LE)

The linear extensibility (LE) of a soil layer is the product of the thickness, in centimeters, multiplied by the COLE of the layer in question. The LE of a soil is the sum of these products for all soil horizons.

Lithic contact (Gr. lithos, stone)

A lithic contact is the boundary between soil and a coherent underlying material. Except in Ruptic-Lithic subgroups the underlying material must be virtually continuous within the limits of a pedon. Cracks that can be penetrated by roots are few, and their horizontal spacing is 10 cm or more. The underlying material must be sufficiently coherent when moist to make hand-digging with a spade impractical, although the material may be chipped or scraped with a spade. If it consists of a single mineral, it must have a hardness by Mohs scale of 3 or more; otherwise, chunks of gravel size that can be broken out must not disperse during 15 hours of shaking in water or in a sodium hexametaphosphate solution. The underlying material considered here does not include diagnostic soil horizons such as a duripan or a petrocalcic horizon.

A lithic contact is diagnostic at the subgroup level if it is within 125 cm of the mineral soil surface of Oxisols and within 50 cm of the mineral soil surface of all other mineral soils.

n value

The *n* value (Pons and Zonneveld, 1965) characterizes the relation between the percentage of water in a soil under field conditions and its percentages of inorganic clay and humus. The *n* value is helpful in predicting whether a soil can be grazed by livestock or can support other loads, and in predicting what degree of subsidence would occur after drainage. For mineral soil materials that are not thixotropic, the *n* value can be calculated by the formula:

$$n = (A - 0.2R)/(L + 3H)$$

A is the percentage of water in the soil in field condition, calculated on a dry-soil basis; *R* is the percentage of silt plus sand; *L* is the percentage of clay; and *H* is the percentage of organic matter (percent organic carbon multiplied by 1.724).

Few data are available in the United States for calculations of the *n* value, but the critical *n* value of 0.7 can be approximated closely in the field by a simple test of squeezing a soil sample in the hand. If the soil flows between the fingers with difficulty, the *n* value is between 0.7 and 1.0; if the soil flows easily between the fingers, the *n* value is 1 or more.

Paralithic contact

A paralithic (lithic like) contact is a contact between soil and paralithic materials (defined below) where the paralithic materials have no cracks or the spacing of cracks that roots can enter is 10 cm or more. It differs from the *densic contact* and the *lithic contact* in that the material forming a densic contact slakes when air dried fragments are submerged in water and the material forming a lithic contact is in a strongly cemented or more cemented rupture resistance class (rock fragments).

Paralithic materials

Paralithic materials are relatively unaltered (do not meet requirements for any other named diagnostic horizons or other diagnostic soil characteristic) materials that have a very weakly cemented to moderately cemented rupture resistance class. Cementation, bulk density, and the organization is such that roots cannot enter except in cracks. Paralithic materials have at their upper boundary a *paralithic contact* if the paralithic materials have no cracks or if the spacing of cracks that roots can enter is 10 cm or more. Commonly these materials are partially weathered bedrock or weakly consolidated bedrock such as sandstone, siltstone, or shale. Paralithic materials can be used to differentiate soil series if the materials are within the series control section (defined below). Fragments of paralithic materials, 2.0 mm or more in diameter, are referred to as pararock fragments.

Permafrost

Permafrost is a layer in which the temperature is perennially at or below 0°C, whether its consistence is very hard or loose. Dry permafrost has loose consistence.

Petroferric contact (Gr. petra, rock, and L. ferrum, iron)

A petroferric contact is a boundary between soil and a continuous layer of indurated material in which iron is an important cement and organic matter is either absent or present only in traces. The indurated layer must be continuous within the limits of each pedon, but may be fractured if the average lateral distance between fractures is 10 cm or more. The fact that this ironstone layer contains little or no organic matter distinguishes it from a placic horizon and from an indurated spodic horizon (ortstein, see below), both of which contain organic matter.

Several features can aid in making the distinction between a lithic and a petroferric contact. First, a petroferric contact is roughly horizontal. Second, the material directly below a petroferric contact contains a high amount of iron (normally 30 percent or more Fe_2O_3). Third, the ironstone sheets below a petroferric contact are thin; their thickness ranges from a few centimeters to very few meters. Sandstone, on the other hand, may be thin or very thick, may be level-bedded or tilted, and may contain only a small percentage of Fe_2O_3. In the tropics, the ironstone is generally more or less vesicular.

Plinthite (Gr. plinthos, brick)

Plinthite is an iron-rich, humus-poor mixture of clay with quartz and other dilutents. It commonly occurs as dark red redox concentrations which usually form platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on exposure to repeated wetting and drying, especially if it is also exposed to heat from the sun. The lower boundary of a zone in which plinthite occurs is usually diffuse or gradual, but it may be abrupt at a lithologic discontinuity.

Generally, plinthite forms in a horizon that is saturated with water for some time during the year. Initially, iron is normally segregated in the form of soft, more or less clayey, red or dark red redox concentrations. These redox concentrations, however, are not considered plinthite unless there has been enough segregation of iron to permit their irreversible hardening on exposure to repeated wetting and drying. Plinthite in the soil is usually firm or very firm when the soil moisture content is near field capacity, and hard when the moisture content is below the wilting point. Plinthite does not harden irreversibly as a result of a single cycle of drying and rewetting; after a single drying, it will remoisten and can then be dispersed in large part by shaking in water with a dispersing agent.

In a moist soil, plinthite is soft enough so that it can be cut with a spade. After irreversible hardening, it is no longer considered plinthite but is called ironstone. Indurated ironstone materials can be broken or shattered with a spade but cannot be dispersed by shaking in water with a dispersing agent.

Sequum and bisequum

The sequence of an eluvial horizon and the underlying B horizon, if one is present, is called a sequum. For example, an albic horizon and a spodic horizon directly below it, or a mollic epipedon and an underlying cambic horizon, or an argillic horizon and a *k* horizon directly below it, constitute a sequum. If two sequa are present in vertical sequence in a single soil, that sequence is called a bisequum.

Slickensides

Slickensides are polished and grooved surfaces that are produced by one soil mass sliding past another. Some slickensides occur at the lower boundary of a slip surface where a mass of soil moves downward on a relatively steep slope. Slickensides are very common in swelling clays that undergo marked changes in moisture content.

Soil moisture regimes

The term *soil moisture regime* refers to the presence or absence either of ground water or of water held at a tension of less than 1500 kPa, in the soil or in specific horizons, by periods of the year. Water held at a tension of 1500 kPa or more is not available to keep most mesophytic plants alive. The availability of water is also affected by dissolved salts. But if a soil is saturated with water that is too salty to be available to most plants, we call such a soil salty rather than dry. Consequently, a horizon is considered dry when

Classes of soil moisture regimes

The soil moisture regimes are defined in terms of the groundwater level, and in terms of the seasonal presence or absence of water held at a tension of less than 1500 kPa in the moisture control section. It is assumed in the definitions that the soil supports whatever vegetation it is capable of supporting, i.e., it may be in crops, grass, or native vegetation, but it is not being irrigated, nor fallowed to increase the amount of stored moisture. These cultural practices affect the soil moisture conditions as long as they are continued.

Aquic moisture regime.—The aquic (L. aqua, water) moisture regime signifies a reducing regime in a soil that is virtually free of dissolved oxygen because it is saturated by ground water or by water of the capillary fringe. Some soils at times are saturated with water while dissolved oxygen is present, either because the water is moving or because the environment is unfavorable for micro-organisms (e.g., if the temperature is less than 1°C); such a regime is not considered aquic.

It is not known how long a soil must be saturated to have an aquic moisture regime, but the duration must be at least a few days, because it is implicit in the concept that dissolved oxygen is virtually absent. Because dissolved oxygen is removed from ground water by respiration of micro-organisms, roots, and soil fauna, it is also implicit in the concept that the soil temperature is above biologic zero (5°C) for some time while the soil is saturated.

Very commonly, the level of ground water fluctuates with the seasons; it is highest in the rainy season, or in fall, winter, or spring if cold weather virtually stops evapotranspiration. There are soils, however, in which the ground water is always at or very close to the surface. A tidal marsh and a closed, landlocked depression fed by perennial streams are examples. Such soils are considered to have a *peraquic moisture regime.*

The distinction between the *aquic moisture regime* and the *peraquic* moisture regime is not closely defined because neither regime is used as a criterion for taxa. These terms can, however, be used in descriptions of taxa.

Some soils with an aquic moisture regime also have a xeric, ustic, or aridic (torric) moisture regime.

amount of stored moisture plus rainfall is approximately equal to, or exceeds, the amount of evapotranspiration. Water moves down through the soil at some time in most years.

In climates where precipitation exceeds evapotranspiration in all months of most years, the moisture tension rarely goes up to 100 kPa in the soil moisture control section, although there are occasional brief periods when some stored moisture is used. The water moves through the soil in all months when it is not frozen. Such an extremely wet moisture regime is called *perudic* (L. *per*, throughout in time; L. *udus*, humid). In the names of most taxa, the formative element *ud* is used to indicate either a udic or a perudic regime; the formative element *per* is used in selected taxa.

Ustic moisture regime.—The ustic (L. ustus, burnt, implying dryness) moisture regime is intermediate between the aridic and the udic regime. Its concept is one of moisture that is limited but is present at a time when conditions are suitable for plant growth. The concept of the ustic moisture regime is not applied to soils that have cryic or pergelic soil temperature regimes (defined below).

If the mean annual soil temperature is 22°C or higher or if the mean summer and winter soil temperatures differ by less than 5°C at a depth of 50 cm below the soil surface, the soil moisture control section in the ustic moisture regime, in 6 or more out of 10 years, is dry in some or all parts for 90 or more cumulative days per year. But the moisture control section is moist in some part either for more than 180 cumulative days per year, or for 90 or more consecutive days.

If the mean annual soil temperature is lower than 22°C and if the mean summer and winter soil temperatures differ by 5°C or more at a depth of 50 cm from the soil surface, the soil moisture control section in the ustic regime is dry in some or all parts for 90 or more cumulative days per year in most years. But it is not dry in all parts for more than half the cumulative days when the soil temperature at a depth of 50 cm is higher than 5°C. If the moisture control section, in 6 or more out of 10 years, is moist in all parts for 45 or more consecutive days in the 4 months following the winter solstice, the moisture control section is dry in all parts for less than 45 consecutive days in the 4 months following the summer solstice.

In tropical and subtropical regions that have a monsoon climate with either one or two dry seasons, summer and winter seasons have little meaning. In those regions, the moisture regime is ustic if there is at least one rainy season of 3 months or more. In temperate regions of subhumid or semiarid climates,

two times as high as the ODOE value for an overlying eluvial horizon. This increase in ODOE value indicates an accumulation of translocated organic materials in an illuvial horizon. Soils with spodic materials show evidence that organic materials and aluminum, with or without iron, have been moved from an eluvial to an illuvial horizon. The morphological, chemical, and physical properties of spodic materials are as follows.

Definition of spodic materials

Spodic materials are mineral soil materials that do not have all the properties of an argillic or a kandic horizon, are dominated by illuvial active amorphous materials composed of organic matter and aluminum, with or without iron, and have both:

1. A pH value in water (1:1) of 5.9 or less and an organic-carbon content of 0.6 percent or more; and

2. One or more of the following:

   a. An overlying albic horizon which extends horizontally through 50 percent or more of each pedon, and have, directly under the albic horizon, colors, moist (crushed and smoothed sample), as follows:

      (1) A hue of 5YR or redder; or

      (2) A hue of 7.5YR, color value of 5 or less, and chroma of 4 or less; or

      (3) A hue of 10YR or neutral and a color value and chroma of 2 or less; or

      (4) A color of 10YR 3/1; or

   b. One of the colors listed above or a hue of 7.5YR, color value, moist, of 5 or less, and chroma of 5 or 6 (crushed and smoothed sample), and one or more of the following morphologic or chemical properties:

      (1) Cementation by organic matter and aluminum, with or without iron, in 50 percent or more of each pedon, and very firm or firmer consistence in the cemented part; or

      (2) Ten percent or more cracked coatings on sand grains; or

      (3) Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.50 or more, and half that amount or less in an overlying umbric (or subhorizon of an

Minerals that are included in the meaning of weatherable minerals are as follows:

1. Clay minerals: All 2:1 lattice clays except one which is currently considered to be an aluminum-interlayered chlorite. Sepiolite, talc, and glauconite are also included in this group of weatherable clay minerals, although they are not everywhere of clay size.

2. Silt- and sand-size minerals (0.02 to 0.2 mm in diameter): Feldspars, feldspathoids, ferromagnesian minerals, glass, micas, zeolites, and apatite.

Obviously, this is a restricted meaning of the term *weatherable minerals*. The intent is to include, in the definitions of diagnostic horizons and various taxa, only those weatherable minerals which are unstable in a humid climate compared to other minerals, such as quartz and 1:1 lattice clays, but which are more resistant to weathering than calcite.

LITERATURE CITED

Brewer, R. 1964. Fabric and mineral analysis of soil. John Wiley and Sons, Inc., New York, London, Sydney. 470 pp.

Pons, L.J., and I.S. Zonneveld. 1965. Soil ripening and soil classification. Initial soil formation in alluvial deposits and a classification of the resulting soils. Int. Inst. Land Reclam. and Impr. Pub. 13. Wageningen, The Netherlands. 128 pp.

Chapter 3

Horizons and Properties Diagnostic for the Higher Categories: Organic Soils[1]

Organic Soil Material

Organic soil material either:

1. Is saturated with water for long periods (or artificially drained) and, excluding live roots, has an organic-carbon content (by weight) of:

    a. 18 percent or more if the mineral fraction contains 60 percent or more clay; or

    b. 12 percent or more if the mineral fraction contains no clay; or

    c. 12 + (clay percentage multiplied by 0.1) percent or more if the mineral fraction contains less than 60 percent clay; or

2. Is never saturated with water for more than a few days and contains 20 percent or more (by weight) organic carbon.

Item 1 in this definition covers materials that have been called peat and muck. Item 2 is intended to include what has been called litter or an O horizon.

Kinds Of Organic Soil Materials

Three different kinds of organic soil materials are distinguished in this taxonomy, based on the degree of decomposition of the plant materials from which they are derived. The three kinds (defined below) are: (1) fibric, (2) hemic, and (3) sapric. Because of the importance of fiber content in the definitions of these materials, fibers are defined before the kinds of organic soil materials, as follows.

Fibers

Fibers, in the terminology of this taxonomy, are pieces of plant tissue in organic soil materials (excluding live roots) which:

[1] Organic soils are referred to as Histosols in this taxonomy.

1. Are large enough to be retained on a 100-mesh sieve (openings 0.15 mm in diameter) when the materials are screened after dispersion in sodium hexametaphosphate; and

2. Show evidence of the cellular structure of the plants from which they are derived; and

3. Are either 2 cm or less in their smallest dimension, or are decomposed enough so they can be crushed and shredded with the fingers.

Pieces of wood which are larger than 2 cm in cross section and which are so undecomposed that they cannot be crushed and shredded with the fingers, such as large branches, logs, and stumps, are not considered to be fibers but coarse fragments (comparable to gravel, stones, and boulders in mineral soils).

Fibric soil materials (L. *fibra*, fiber)

Fibric soil materials are organic soil materials which either:

1. Contain three-fourths[2] or more (by volume) fibers after rubbing, excluding rock fragments; *or*

2. Contain two-fifths or more (by volume) fibers after rubbing, excluding rock fragments; and yield color values and chromas of 7/1, 7/2, 8/1, 8/2, or 8/3 (Munsell designations) on white chromatographic or filter paper that is inserted into a paste made of the soil materials in a saturated sodium pyrophosphate solution.

Hemic soil materials (Gr. *hemi*, half; implying intermediate decomposition)

Hemic soil materials are intermediate in their degree of decomposition between the less decomposed fibric and more decomposed sapric materials. Their morphological features give intermediate values for fiber content, bulk density, and water content. They are partly altered both physically and biochemically.

Sapric soil materials (Gr. *sapros*, rotten)

These are the most highly decomposed of the three kinds of organic soil materials. They have the smallest amount of plant fiber, the highest bulk density, and the lowest water content on a dry-weight basis at saturation. Sapric soil materials are commonly very dark gray to black. They are relatively

---

[2]Fractions are used rather than percentages to avoid implying a higher degree of accuracy than is justified.

section has a thickness of either 130 cm or 160 cm from the soil surface, if there is no densic, lithic, or paralithic contact, thick layer of water, or permafrost within the respective limit. The thicker control section is used if the surface soil layer to a depth of 60 cm either contains three fourths or more fibers derived from *Sphagnum*, *Hypnum*, or other mosses, or has a bulk density of less than 0.1 g/cm^3. Layers of water, which may be between a few centimeters and many meters thick in these soils, are considered to be the lower boundary of the control section only if the water extends below a depth of 130 or 160 cm, respectively. A densic, lithic, or paralithic contact, if shallower than 130 or 160 cm, constitutes the lower boundary of the control section; or the lower boundary of the control section is 25 cm below the upper limit of permafrost 2 months after the summer solstice. An unconsolidated mineral substratum shallower than those limits does not change the lower boundary of the control section.

The control section of Histosols is divided somewhat arbitrarily into three tiers: surface, subsurface, and bottom tiers.

Surface tier

The surface tier of a Histosol extends from the soil surface to a depth of 60 cm if either (1) the materials within that depth are fibric and three fourths or more of the fiber volume is derived from sphagnum or other mosses, or (2) the materials have a bulk density of less than 0.1 g/cm^3; otherwise, the surface tier extends from the soil surface to a depth of 30 cm.

On some organic soils, a surface mineral layer less than 40 cm thick is present as a result of flooding, volcanic eruptions, additions of mineral materials to increase soil strength or reduce frost hazard, or other causes. If such a mineral layer is less than 30 cm thick, it constitutes the upper part of the surface tier; if it is 30 to 40 cm thick, it constitutes the whole surface tier and part of the subsurface tier.

Subsurface tier

The subsurface tier is normally 60 cm thick. If, however, the control section ends at a shallower depth (at a densic, lithic, or paralithic contact or a water layer, or in permafrost), the subsurface tier extends from the lower boundary of the surface tier to the lower boundary of the control section. It includes any unconsolidated mineral layers that may be present within those depths.

Bottom tier

The bottom tier is 40 cm thick unless the control section has its lower boundary at a shallower depth (at a densic, lithic, or paralithic contact or a water layer, or in permafrost).

If a soil profile includes a buried soil, the present soil surface is used to determine soil moisture and temperature, and depth to and thickness of diagnostic horizons and other diagnostic soil characteristics. Diagnostic horizons of the buried soil are not considered in selecting taxa unless the criteria in the keys specifically indicate buried horizons, such as in Thapto-histic subgroups. Most other diagnostic soil characteristics of the buried soil are not considered, however organic carbon if Holocene age, andic soil properties, base saturation, and all properties used to determine family and series placement are considered.

Conventional rounding conventions should be used to determine numerical values.

Soil colors, (hue, value, and chroma) are used in many of the criteria that follow. Soil colors typically change value and some change hue and chroma depending on the water state. In many of the criteria of the keys, the water state is specified. If no water state is specified, the soil is considered to meet the criterion if it meets the criterion when moist or dry or both moist and dry.

Key To Soil Orders

A. Soils which:

1. Do not have andic soil properties in 60 percent or more of the thickness between the soil surface and either a depth of 60 cm, or a densic, lithic, or paralithic contact or duripan if shallower; *and*

2. Have organic soil materials that meet *one or more* of the following:

   a. Overlie cindery, fragmental, or pumiceous materials and/or fill their interstices[1], *and* directly below these materials either a densic, lithic, or paralithic contact; *or*

   b. When added with underlying cindery, fragmental, or pumiceous materials total 40 cm or more between the soil surface and a depth of 50 cm; *or*

[1] Materials that meet the definition of cindery, fragmental, or pumiceous except have more than 10 percent (by volume) voids that are filled with organic soil materials are considered as organic soil materials.

c. Constitute two thirds or more of the total thickness of the soil to a densic, lithic, or paralithic contact *and* mineral soils which, if present, have a total thickness of 10 cm or less; *or*

d. Are saturated with water for 6 months or more per year in most years (or artificially drained), and have an upper boundary within 40 cm of the soil surface, and have a total thickness of *either*:

(1) 60 cm or more if three fourths or more of their volume consists of moss fibers, or if their bulk density, moist, is less than 0.1 g/cm^3; *or*

(2) 40 cm or more if they consist either of sapric or hemic materials, or of fibric materials with less than three fourths (by volume) moss fibers and a bulk density, moist, of 0.1 g/cm^3 or more.
Histosols, p. 305

B. Other soils which do not have a plaggen epipedonoran argillic or kandic horizon above a spodic horizon, *and* have *one or more* of the following:

1. A spodic horizon, an albic horizon in 50 percent or more of each pedon, and a cryic or pergelic soil temperature regime; *or*

2. An Ap horizon containing 85 percent or more spodic materials; *or*

3. A spodic horizon with *all* the following characteristics:

a. *One or more* of the following:

(1) A thickness of 10 cm or more; *or*

(2) An overlying Ap horizon; *or*

(3) Cementation in 50 percent or more of each pedon; *or*

(4) A coarse-loamy, loamy-skeletal, or finer particle size, and a frigid temperature regime in the soil; *or*

(5) A cryic or pergelic temperature regime in the soil; *and*

b. An upper boundary within the following depths from the mineral soil surface: *either*

(1) Less than 50 cm; *or*

(2) Less than 200 cm if the soil has a sandy particle size between the mineral soil surface and the spodic horizon; *and*

c. A lower boundary as follows:

(1) *Either* at a depth of 25 cm or more below the mineral soil surface, *or* at the top of a duripan or fragipan, or at a densic, lithic, paralithic, or petroferric†contact, whichever is shallowest; *or*

(2) At any depth,

(a) If the spodic horizon has a coarse-loamy, loamy-skeletal, or finer particle size, and the soil has a frigid temperature regime, *or*

(b) If the soil has a cryic or pergelic temperature regime; *and*

d. *Either*:

(1) A directly overlying albic horizon in 50 percent or more of each pedon, *or*

(2) No andic soil properties in 60 percent or more of the thickness *either*:

(a) Within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

(b) Between either the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, duripan, or petrocalcic horizon.

Spodosols, p. 503

C. Other soils that have andic soil properties in 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

2. Between either the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, duripan, or petrocalcic horizon.

Andisols, p.161

D. Other soils which have *either*:

1. An oxic horizon that has its upper boundary within 150 cm of the mineral soil surface, and no kandic horizon that has its upper boundary within that depth; *or*

2. 40 percent or more (by weight) clay in the fine-earth fraction between the mineral soil surface and a depth of 18 cm (after mixing), *and* a kandic horizon that has the weatherable-mineral properties of an oxic horizon and has its upper boundary within 100 cm of the mineral soil surface.

Oxisols, p. 471

E. Other soils which have:

1. A layer 25 cm or more thick, with an upper boundary within 100 cm of the mineral soil surface, that has *either* slickensides close enough to intersect *or* wedge-shaped aggregates which have their long axes tilted 10 to 60 degrees from the horizontal; *and*

2. A weighted average of 30 percent or more clay in the fine-earth fraction either between the mineral soil surface and a depth of 18 cm or in an Ap horizon, whichever is thicker, *and* 30 percent or more clay in the fine-earth fraction of all horizons between a depth of 18 cm and either a depth of 50 cm, or a densic, lithic, or paralithic contact, duripan, or petrocalcic horizon if shallower; *and*

(2) At a densic, lithic, paralithic, or petroferric contact if shallower; *or*

b. The shallowest of the following depths:

(1) 125 cm below the upper boundary of the argillic or kandic horizon; *or*

(2) 180 cm below the mineral soil surface; *or*

(3) At a densic, lithic, paralithic, or petroferric contact; *or*

2. A fragipan and *both* of the following:

a. Either an argillic or a kandic horizon above, within, or below it, or clay films 1 mm or more thick in one or more of its subhorizons; *and*

b. A base saturation (by sum of cations) of less than 35 percent at the shallowest of the following depths:

(1) 75 cm below the upper boundary of the fragipan; *or*

(2) 200 cm below the mineral soil surface; *or*

(3) At a densic, lithic, paralithic, or petroferric contact.

Ultisols, p. 521

H. Other soils that have *both* of the following:

1. *Either*

a. A mollic epipedon; *or*

b. *Both* a surface horizon which meets all the requirements for a mollic epipedon except thickness after the soil has been mixed to a depth of 18 cm, *and* a subhorizon more than 7.5 cm thick, within the upper part of an argillic, a kandic, or a natric horizon, that meets the color, organic-carbon content, base saturation, and structure requirements of a mollic epipedon but is separated from the surface horizon by an albic horizon; *and*

b. *One or both* of the following:

(1) A histic, a mollic, a plaggen, or an umbric epipedon, *or*

(2) In 50 percent or more of the layers between the mineral soil surface and a depth of 50 cm, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more), which decreases with increasing depth below 50 cm, *and* also ground water within 100 cm of the mineral soil surface at some time during the year when the soil is not frozen in any part.

Inceptisols, p. 325

K. Other soils.

Entisols, p. 261

Aqualfs

Key to great groups

IAA. Aqualfs that have one or more horizons between 30 and 150 cm from the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.
Plinthaqualfs, p. 85

IAB. Other Aqualfs that have a duripan.
Duraqualfs, p. 71

IAC. Other Aqualfs that have a natric horizon.
Natraqualfs, p. 84

IAD. Other Aqualfs that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.
Fragiaqualfs, p. 80

IAE. Other Aqualfs that have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.
Kandiaqualfs, p. 83

IAF. Other Aqualfs that have one or more layers at least 25 cm thick (cumulative) within a depth of 100 cm from the mineral soil surface, which have 50 percent or more (by volume) recognizable bioturbation such as filled animal burrows, wormholes, or casts.
Vermaqualfs, p.86

IAG. Other Aqualfs that have a glossic horizon.
Glossaqualfs, p. 81

IAH. Other Aqualfs that have an abrupt textural change between the ochric epipedon or albic horizon and the argillic horizon, and have a low or very low saturated hydraulic conductivity in the argillic horizon.
Albaqualfs, p. 69

IAI. Other Aqualfs that have an umbric epipedon.
Umbraqualfs, p 85

IAJ. Other Aqualfs that have episaturation.
Epiaqualfs, p. 74

IAK. Other Aqualfs.
Endoaqualfs, p.71

Albaqualfs

Key to subgroups

IAHA. Albaqualfs that have a sandy or sandy-skeletal particle size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Albaqualfs

IAHB. Other Albaqualfs which have *both* of the following:

1. *One or both*:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. A chroma of 3 or more in 40 percent or more of the matrix between the lower boundary of the A or Ap horizon and a depth of 75 cm from the mineral soil surface.

Aeric Vertic Albaqualfs

IAHC. Other Albaqualfs which have *both* of the following:

1. *One or both*:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. An Ap horizon or materials between the mineral soil surface and 18 cm that after mixing meet *one or more* the following colors;

a. A color value, moist, of 4 or more; *or*

b. A color value, dry, of 6 or more; *or*

c. A chroma of 4 or more.

Chromic Vertic Albaqualfs

IAHD. Other Albaqualfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A li t r h b l t f 6/0 b t h

o o r

sem s ne e

ur a

a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Endoaqualfs

IAKB. Other Endoaqualfs that have:

1. Fragic soil properties;

a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, one, or a combination, of the following colors:

a. A hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

(1). If peds are present, a chroma of 2 or more on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less in ped interiors; *or*

(2). If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

b. In 50 percent or more of the matrix, a hue of 10YR or yellower *and either*

(1) Both a color value, moist, and chroma of 3 or more; *or*

(2) A chroma of 2 or more if there are no redox concentrations.

Aeric Fragic Endoaqualfs

IAKC. Other Endoaqualfs that have fragic soil properties;

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Endoaqualfs

IAKD. Other Endoaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Endoaqualfs

IAKE. Other Endoaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Endoaqualfs

IAKF. Other Endoaqualfs which have *both*:

1. A mollic epipedon, or an Ap horizon that meets all the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing; *and*

2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, one, or a combination, of the following colors:

   a. A hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

      (1). If peds are present, a chroma of 2 or more on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less in ped interiors; *or*

      (2). If peds are absent, a chroma of 2 or more in 50 percent or more of the matrix; *or*

   b. In 50 percent or more of the matrix, a hue of 10YR or yellower *and either*

      (1) Both a color value, moist, and chroma of 3 or more; *or*

      (2) A chroma of 2 or more if there are no redox concentrations.

Udollic Endoaqualfs

IAKG. Other Endoaqualfs that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one, or a combination, of the following colors:

1. Hue of 7.5YR or redder; *and*

   a. Peds present and a chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less (both moist and dry) in ped interiors; *or*

b. No peds present and a chroma of 2 or more (both moist and dry); *or*

2. Hue of 10YR or yellower *and either*

a. Both a color value, moist, and chroma of 3 or more (both moist and dry); *or*

b. A chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Endoaqualfs

IAKH. Other Endoaqualfs which have a mollic epipedon, or an Ap horizon that meets all the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Endoaqualfs

IAKI. Other Endoaqualfs which have an Ap horizon that meets all the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Umbric Endoaqualfs

IAKJ. Other Endoaqualfs.

Typic Endoaqualfs

Epiaqualfs

Key to subgroups

IAJA. Epiaqualfs which have *all* of the following:

1. *One or both*:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

a. Hue of 7.5YR or redder; *and*

(1) Peds present and a chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less (both moist and dry) in ped interiors; *or*

(2) No peds present and a chroma of 2 or more (both moist and dry); *or*

b. Hue of 10YR or yellower *and either*

(1) Both a color value, moist, and chroma of 3 or more (both moist and dry); *or*

(2) A chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Vertic Epiaqualfs

IAJC. Other Epiaqualfs which have *both* of the following:

1. *One or both*:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides *or* wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. An Ap horizon or materials between the mineral soil surface and 18 cm that after mixing meet *one or more* the following colors:

a. A color value, moist, of 4 or more; *or*

b. A color value, dry, of 6 or more; *or*

c. A chroma of 4 or more.

Chromic Vertic Epiaqualfs

IAJD. Other Epiaqualfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of

30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Epiaqualfs

IAJE. Other Epiaqualfs which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Epiaqualfs

IAJF. Other Epiaqualfs that have:

1. Fragic soil properties;

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one, or a combination, of the following colors:

a. Hue of 7.5YR or redder; *and*

(1) Peds present and a chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less (both moist and dry) in ped interiors; *or*

(2) No peds present and a chroma of 2 or more (both moist and dry); *or*

b. Hue of 10YR or yellower *and either*

(1) Both a color value, moist, and chroma of 3 or more (both moist and dry); *or*

(2) A chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Fragic Epiaqualfs

IAIG. Other Epiaqualfs that have fragic soil properties;

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Epiaqualfs

IAJH. Other Epiaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Epiaqualfs

IAJI. Other Epiaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Epiaqualfs

IAJJ. Other Epiaqualfs which have:

1. An Ap horizon that meets all the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing; *and*

2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one, or a combination, of the following colors:

1. Hue of 7.5YR or redder; *and*

   a. Peds present and a chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less (both moist and dry) in ped interiors; *or*

   b. No peds present and a chroma of 2 or more (both moist and dry); *or*

2. Hue of 10YR or yellower *and either*

   a. Both a color value, moist, and chroma of 3 or more (both moist and dry); *or*

   b. A chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Epiaqualfs

IAJM. Other Epiaqualfs which have a mollic epipedon, or an Ap horizon that meets all the requirements for a mollic epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Mollic Epiaqualfs

IAJN. Other Epiaqualfs which have an Ap horizon that meets all the requirements for an umbric epipedon except thickness, or materials between the soil surface and a depth of 18 cm that meet these requirements after mixing.

Umbric Epiaqualfs

IAJO. Other Epiaqualfs.

Typic Epiaqualfs

Fragiaqualfs

<u>Key to subgroups</u>

IADA. Fragiaqualfs that have one or more layers at least 25 cm thick (cumulative) within a depth of 100 cm from the mineral soil surface, which have 25 percent or more (by volume) recognizable bioturbation such as filled animal burrows, wormholes, or casts.

Vermic Fragiaqualfs

IADB. Other Fragiaqualfs that have, between the A or Ap horizon and a fragipan, a horizon with 50 percent or more chroma of 3 or more if the hue is 10YR or redder, or of 4 or more if the hue is 2.5Y or yellower.

Aeric Fragiaqualfs

IADC. Other Fragiaqualfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
Plinthic Fragiaqualfs

IADD. Other Fragiaqualfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.
Umbric Fragiaqualfs

IADE. Other Fragiaqualfs.
Typic Fragiaqualfs

Glossaqualfs

Key to subgroups

IAGA. Glossaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm to 100 cm.
Arenic Glossaqualfs

IAGB. Other Glossaqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.
Grossarenic Glossaqualfs

IAGC. Other Glossaqualfs that have:

1. Fragic soil properties;

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, one, or a combination, of the following colors:

   a. A hue of 7.5YR or redder in 50 percent or more of the matrix; *and*

      (1). If peds are present, a chroma of 2 or more on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less in ped interiors; *or*

IAEE. Other Kandiaqualfs that have, in one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, in 50 percent or more of the matrix, one, or a combination, of the following colors:

1. Hue of 7.5YR or redder; *and*

    a. Peds present and a chroma of 2 or more (both moist and dry) on 50 percent or more of ped exteriors, or no redox depletions with a chroma of 2 or less (both moist and dry) in ped interiors; *or*

    b. No peds present and a chroma of 2 or more (both moist and dry); *or*

2. Hue of 10YR or yellower *and either*

    a. Both a color value, moist, and chroma of 3 or more (both moist and dry); *or*

    b. A chroma of 2 or more (both moist and dry) and no redox concentrations.

Aeric Kandiaqualfs

IAEF. Other Kandiaqualfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Umbric Kandiaqualfs

IAEG. Other Kandiaqualfs.

Typic Kandiaqualfs

Natraqualfs

Key to subgroups

IACA. Natraqualfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natraqualfs

IACB. Other Natraqualfs that have one or more layers at least 25 cm thick (cumulative) within a depth of 100 cm from the mineral soil surface, which have 25 percent or more (by volume) recognizable bioturbation such as filled animal burrows, wormholes, or casts.
Vermic Natraqualfs

IACC. Other Natraqualfs that have *both*:

1. A glossic horizon, or interfingering of albic materials into the natric horizon; *and*

2. In all horizons within 40 cm of the mineral soil surface, an exchangeable sodium percentage of less than 15 percent, and less magnesium and sodium than calcium and extractable acidity.
Albic Glossic Natraqualfs

IACD. Other Natraqualfs that have an exchangeable sodium percentage of less than 15 percent, and less magnesium and sodium than calcium and extractable acidity, either throughout the upper 15 cm of the natric horizon, or in all horizons within 40 cm of the mineral soil surface, whichever is deeper.
Albic Natraqualfs

IACE. Other Natraqualfs that have a glossic horizon, or interfingering of albic materials into the natric horizon.
Glossic Natraqualfs

IACF. Other Natraqualfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.
Mollic Natraqualfs

IACG. Other Natraqualfs.
Typic Natraqualfs

Plinthaqualfs

IAAA. All Plinthaqualfs (provisionally).
Typic Plinthaqualfs

Umbraqualfs

Key to subgroups

IAIA. Umbraqualfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Umbraqualfs

IAIB. Other Umbraqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Umbraqualfs

IAIC. Other Umbraqualfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Umbraqualfs

IAID. Other Umbraqualfs that have, in one or more horizons above the argillic horizon, 5 percent or more (by volume) discrete nodules 2.5 to 30 cm in diameter that are cemented by iron.

Ferrudalfic Umbraqualfs

IAIE. Other Umbraqualfs.

Typic Umbraqualfs

Vermaqualfs

Key to subgroups

IAFA. Vermaqualfs that have an exchangeable sodium percentage of 7 or more (or a sodium adsorption ratio of 6 or more): *either* or *both*

1. Throughout the upper 15 cm of the argillic horizon; *and/or*

2. Throughout all horizons within 40 cm of the mineral soil surface.

Natric Vermaqualfs

IAFB. Other Vermaqualfs.

Typic Vermaqualfs

Boralfs

Key to great groups

IBA. Boralfs which have *all* of the following:

1. An argillic horizon that has its upper boundary 60 cm or more below the mineral surface; *and*

2. A texture finer than loamy fine sand in one or more horizons above the argillic horizon; *and*

3. Either a glossic horizon, or interfingering of albic materials into the argillic horizon.

Paleboralfs, p. 98

IBB. Other Boralfs that have a fragipan with its upper boundary within 100 cm if the mineral soil surface.

Fragiboralfs, p. 95

IBC. Other Boralfs that have a natric horizon.

Natriboralfs, p. 98

IBD. Other Boralfs that have a cryic soil temperature regime.

Cryoboralfs, p. 87

IBE. Other Boralfs that have *both*:

1. A base saturation (by sum of cations) of 60 percent or more in all subhorizons of the argillic horizon; *and*

2. A moisture control section that is dry in one or more horizons for some time in most years.

Eutroboralfs, p. 90

IBF. Other Boralfs.

Glossoboralfs, p. 96

Cryoboralfs

Key to subgroups

IBDA. Cryoboralfs that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. A color value, moist, of 3 or less (crushed and smoothed sample) either in an Ap horizon, or between the soil surface and a depth of 15 cm, after mixing.

Lithic Mollic Cryoboralfs

Eutroboralfs

Key to subgroups

IBEA. Eutroboralfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Eutroboralfs

IBEB. Other Eutroboralfs which have both:

1. One or both of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

   a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

   b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.

Aquertic Eutroboralfs

IBEC. Other Eutroboralfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Eutroboralfs

IBED. Other Eutroboralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Eutroboralfs

IBEE. Other Eutroboralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Eutroboralfs

IBEF. Other Eutroboralfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Aquic Arenic Eutroboralfs

IBEG. Other Eutroboralfs that have *both*:

1. Fragic soil properties;

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

A
L
F

a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.
Fragiaquic Eutroboralfs

IBEH. Other Eutroboralfs which have *both*:

1. A glossic horizon; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

   a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

   b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.
Glossaquic Eutroboralfs

IBEI. Other Eutroboralfs that have redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

1. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

2. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.
Aquic Eutroboralfs

IBEJ. Other Eutroboralfs which have *both*

1. An argillic horizon that:

   a. Consists entirely of lamellae; *or*

   b. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

   c. Consists of one or more subhorizons which are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there is either:

(1) Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

(2) A combination of lamellae (that may or may not be part of the argillic horizon), and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon; *and*

2. Saturation with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Lamellic Oxyaquic Eutroboralfs

IBEK. Other Eutroboralfs which:

1. Have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick; *and*

2. Are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Psammentic Eutroboralfs

IBEL. Other Eutroboralfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. Saturation with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Arenic Oxyaquic Eutroboralfs

IBEM. Other Eutroboralfs which have *both*:

1. A glossic horizon; *and*

2. Saturation with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Glossic Oxyaquic Eutroboralfs

IBEN. Other Eutroboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Eutroboralfs

materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Mollic Eutroboralfs

IBEV. Other Eutroboralfs.

Typic Eutroboralfs

Fragiboralfs

Key to subgroups

IBBA. Fragiboralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Fragiboralfs

IBBB. Other Fragiboralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Fragiboralfs

IBBC. Other Fragiboralfs that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Fragiboralfs

IBBD. Other Fragiboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Fragiboralfs

a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.

Fragiaquic Glossoboralfs

IBFE. Other Glossoboralfs that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Glossoboralfs

IBFF. Other Glossoboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Glossoboralfs

IBFG. Other Glossoboralfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Glossoboralfs

IBFH. Other Glossoboralfs that have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons which are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there is either:

   a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

   b. A combination of lamellae (that may or may not be part of the argillic horizon), and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Glossoboralfs

IBFI. Other Glossoboralfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Glossoboralfs

IBFJ. Other Glossoboralfs that have an argillic horizon 35 cm or less thick.

Ochreptic Glossoboralfs

IBFK. Other Glossoboralfs that do not have a glossic horizon.

Eutric Glossoboralfs

IBFL. Other Glossoboralfs.

Typic Glossoboralfs

Natriboralfs

IBCA. All Natriboralfs (provisionally).

Typic Natriboralfs

Paleboralfs

Key to subgroups

IBAA. Paleboralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Paleboralfs

IBAB. Other Paleboralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Paleboralfs

IBAC. Other Paleboralfs that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Paleboralfs

IBAD. Other Paleboralfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Paleboralfs

IBAE. Other Paleboralfs which have an argillic horizon that has, in its fine-earth fraction, a clay increase with depth of 20 percent or more (absolute) within its upper 7.5 cm.

Abruptic Paleboralfs

IBAF. Other Paleboralfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Mollic Paleboralfs

IBAG. Other Paleboralfs.

Typic Paleboralfs

Udalfs

Key to great groups

IEA. Udalfs that have an agric horizon.

Agrudalfs, p. 101

IEB. Other Udalfs that have a natric horizon.

Natrudalfs, p. 118

IEC. Other Udalfs which have:

1. A discontinuous albic horizon or no albic horizon above the argillic horizon; *and*

2. An argillic horizon that is discontinuous horizontally; *and*

3. In the argillic horizon, discrete nodules 2.5 cm to 30 cm in diameter with exteriors that (a) are enriched and weakly cemented to indurated with iron, and (b) have either a redder hue or a higher chroma than the interiors.

Ferrudalfs, p. 101

IED. Other Udalfs that have a glossic horizon and have a fragipan with its upper boundary within 100 cm of the mineral soil surface.

Fraglossudalfs, p. 104

IEE. Other Udalfs that have a glossic horizon.

Glossudalfs, p. 104

IEF. Other Udalfs that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.

Fragiudalfs, p. 102

IEG. Other Udalfs which:

1. Do not have a densic, lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *and*

3. Within 150 cm of the mineral soil surface, *either*

   a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

   b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

Kandiudalfs, p. 115

IEH. Other Udalfs that have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

Kanhapludalfs, p. 117

IEI. Other Udalfs which:

1. Do not have a densic, lithic, or paralithic contact within 150 cm of the mineral soil surface; *and*

2. Within 150 cm of the mineral soil surface, *either*

a. Do not have a clay decrease with depth of 20 percent or more (relative) from the maximum clay content; *or*

b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction; *and*

3. Have *one or more* of the following in the argillic horizon:

a. In the matrix of its lowest subhorizon, a hue redder than 10YR and 50 percent or more chroma of 5 or more; *or*

b. In 50 percent or more of its matrix, a hue of 2.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, of 4 or less; *or*

c. In one or more subhorizons, many coarse redox concentrations with a hue redder than 7.5YR or a chroma of 6 or more, or both.

Paleudalfs, p. 118

IEJ. Other Udalfs that have in *all* horizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodudalfs, p. 122

IEK. Other Udalfs.

Hapludalfs, p. 107

Agrudalfs

IEAA. All Agrudalfs (provisionally).

Typic Agrudalfs

Ferrudalfs

Key to subgroups

IECA. Ferrudalfs that have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Ferrudalfs

2. In one or more horizons within 40 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Glossaquic Fragiudalfs

IEFD. Other Fragiudalfs which:

1. Do not, above the fragipan, have an argillic horizon with clay films on both vertical and horizontal faces of any peds; *and*

2. Have, in one or more horizons within 40 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aqueptic Fragiudalfs

IEFE. Other Fragiudalfs that have *both*:

1. In one or more horizons within 40 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Within a vertical distance of 7.5 cm at the top of the argillic horizon, a clay increase of more than 15 percent (absolute) in the fine-earth fraction.
Albaquic Fragiudalfs

IEFF. Other Fragiudalfs that have, in one or more horizons within 40 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Fragiudalfs

IEFG. Other Fragiudalfs that are saturated with water, in one or more layers above the fragipan, for 1 month or more per year in 6 or more out of 10 years.
Oxyaquic Fragiudalfs

IEFH. Other Fragiudalfs that have, directly above the fragipan, a layer 5 cm or more thick which *either*:

1. Has, on faces of primary peds, clay depletions of clean silt and sand that constitute 1 percent or more (by volume) of the layer; *or*

2. Is an eluvial horizon (E) and has 3 or more percent (absolute) less clay in the fine-earth fraction than both the overlying and underlying horizons.
Glossic Fragiudalfs

IEFI. Other Fragiudalfs that do not, above the fragipan, have an argillic horizon with clay films on both vertical and horizontal faces of any peds.
Ochreptic Fragiudalfs

IEFJ. Other Fragiudalfs.
Typic Fragiudalfs

Fraglossudalfs

Key to subgroups

IEDA. Fraglossudalfs that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Fraglossudalfs

IEDB. Other Fraglossudalfs that are saturated with water, in one or more layers above the fragipan, for 1 month or more per year in 6 or more out of 10 years.
Oxyaquic Fraglossudalfs

IEDC. Other Fraglossudalfs.
Typic Fraglossudalfs

Glossudalfs

Key to subgroups

IEEA. Glossudalfs which have *both*:

1. In one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

    a. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

    b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

c. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

(1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

(2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Glossudalfs

IEEB. Other Glossudalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Glossudalfs

IEEC. Other Glossudalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Glossudalfs

IEED. Other Glossudalfs that have *both*:

1. Fragic soil properties;

a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

   a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

   b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.

Fragiaquic Glossudalfs

IEEE. Other Glossudalfs that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Glossudalfs

IEEF. Other Glossudalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Glossudalfs

IEEG. Other Glossudalfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Glossudalfs

IEEH. Other Glossudalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Glossudalfs

IEEI. Other Glossudalfs that do not have a glossic horizon 50 cm or more thick.

Haplic Glossudalfs

IEEJ. Other Glossudalfs.

Typic Glossudalfs

Hapludalfs

Key to subgroups

IEKA. Hapludalfs that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. In one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Lithic Hapludalfs

IEKB. Other Hapludalfs that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Hapludalfs

IEKC. Other Hapludalfs which have *all* of the following:

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

   a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

   b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface; *and*

3. An Ap horizon or materials between the mineral soil surface and 18 cm that after mixing meet *one or more* the following colors;

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Oxyaquic Vertic Hapludalfs

IEKF. Other Hapludalfs which have *both*

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. An Ap horizon or materials between the mineral soil surface and 18 cm that after mixing meet *one or more* the following colors;

   a. A color value, moist, of 4 or more; *or*

   b. A color value, dry, of 6 or more; *or*

   c. A chroma of 4 or more.

Chromic Vertic Hapludalfs

IEKG. Other Hapludalfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Hapludalfs

IEKH. Other Hapludalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Hapludalfs

IEKI. Other Hapludalfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Hapludalfs

IEKJ. Other Hapludalfs that have both:

1. Fragic soil properties;

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

   a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

   b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.

Fragiaquic Hapludalfs

IEKV. Other Hapludalfs that have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons which are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there is either:

   a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

   b. A combination of lamellae (that may or may not be part of the argillic horizon), and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Hapludalfs

IEKW. Other Hapludalfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Hapludalfs

IEKX. Other Hapludalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Hapludalfs

IEKY. Other Hapludalfs that have *both*:

1. Five percent or more (by volume) albic materials in one or more subhorizons of the argillic horizon; *and*

2. A mean annual soil temperature of 10°C or higher.

Glossic Hapludalfs

IEKZ. Other Hapludalfs that have *both*:

1. In the upper part of the argillic horizon, interfingering of albic materials and albic materials surrounding some peds; *and*

2. A mean annual soil temperature lower than 10°C.

Glossoboric Hapludalfs

IEKZa. Other Hapludalfs that have an argillic horizon 35 cm or less thick.

Ochreptic Hapludalfs

IEKZb. Other Hapludalfs that have a base saturation (by sum of cations) of less than 60 percent at a depth of 125 cm below the top of the argillic horizon, or at a depth of 180 cm below the mineral soil surface, or directly above a densic, lithic, or paralithic contact, whichever is shallowest.

Ultic Hapludalfs

IEKZc. Other Hapludalfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Mollic Hapludalfs

IEKZd. Other Hapludalfs.

Typic Hapludalfs

Kandiudalfs

Key to subgroups

IEGA. Kandiudalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthaquic Kandiudalfs

IEGB. Other Kandiudalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiudalfs

IEGC. Other Kandiudalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Kandiudalfs

IEGD. Other Kandiudalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kandiudalfs

IEGE. Other Kandiudalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Grossarenic Plinthic Kandiudalfs

IEGF. Other Kandiudalfs that have a sandy or sandy-skeletal particle- size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Kandiudalfs

IEGG. Other Kandiudalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Kandiudalfs

IEGH. Other Kandiudalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiudalfs

IEGI. Other Kandiudalfs that have in *all* horizons in the upper 100 cm of the argillic or kandic horizon or throughout the entire argillic or kandic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodic Kandiudalfs

IEGJ. Other Kandiudalfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.
Mollic Kandiudalfs

IEGK. Other Kandiudalfs.
Typic Kandiudalfs

Kanhapludalfs

Key to subgroups

IEHA. Kanhapludalfs that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Kanhapludalfs

IEHB. Other Kanhapludalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Kanhapludalfs

IEHC. Other Kanhapludalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
Oxyaquic Kanhapludalfs

IEHD. Other Kanhapludalfs that have in *all* horizons in the upper 100 cm of the argillic or kandic horizon or throughout the entire argillic or kandic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodic Kanhapludalfs

IEHE. Other Kanhapludalfs.
Typic Kanhapludalfs

Natrudalfs

Key to subgroups

IEBA. Natrudalfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrudalfs

IEBB. Other Natrudalfs that have either a glossic horizon, or interfingering of albic materials into the natric horizon.

Glossic Natrudalfs

IEBC. Other Natrudalfs that have an Ap horizon with a color value, moist, of 2 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have that color value after mixing.

Mollic Natrudalfs

IEBD. Other Natrudalfs.

Typic Natrudalfs

Paleudalfs

Key to subgroups

IEIA. Paleudalfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Paleudalfs

IEIB. Other Paleudalfs that have *both*:

1. Fragic soil properties;

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

   a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

   b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.

Fragiaquic Paleudalfs

IEIC. Other Paleudalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthaquic Paleudalfs

IEID. Other Paleudalfs which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. In the upper part of the argillic horizon, one or more subhorizons that have 5 percent or more (by volume) clay depletions with a chroma of 2 or less.

Glossaquic Paleudalfs

IEIE. Other Paleudalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A clay increase of 15 percent or more (absolute) in the fine-earth fraction within a vertical distance of 2.5 cm at the upper boundary of the argillic horizon.

Albaquic Paleudalfs

IEIF. Other Paleudalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Paleudalfs

IEIG. Other Paleudalfs that have anthraquic conditions.

Anthraquic Paleudalfs

IEIH. Other Paleudalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Paleudalfs

IEII. Other Paleudalfs that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Paleudalfs

IEIJ. Other Paleudalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Paleudalfs

IEIK. Other Paleudalfs that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Grossarenic Plinthic Paleudalfs

IEIL. Other Paleudalfs which have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons which are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there is either:

    a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

    b. A combination of lamellae (that may or may not be part of the argillic horizon), and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Paleudalfs

IEIM. Other Paleudalfs which have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Paleudalfs

IEIN. Other Paleudalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleudalfs

IEIO. Other Paleudalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleudalfs

IEIP. Other Paleudalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Paleudalfs

IEIQ. Other Paleudalfs that have *either*:

1. In the upper part of the argillic horizon, one or more subhorizons that have 5 percent or more (by volume) skeletans with a chroma of 2 or less; *or*

2. Five percent or more (by volume) albic materials in some subhorizon of the argillic horizon.

Glossic Paleudalfs

IEIR. Other Paleudalfs that have in *all* horizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodic Paleudalfs

IEIS. Other Paleudalfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Mollic Paleudalfs

IEIT. Other Paleudalfs.

Typic Paleudalfs

Rhodudalfs

IEJA. All Rhodudalfs (provisionally).

Typic Rhodudalfs

Ustalfs

Key to great groups

ICA. Ustalfs which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Durustalfs, p. 124

ICB. Other Ustalfs that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.

Plinthustalfs, p. 145

ICC. Other Ustalfs that have a natric horizon.

Natrustalfs, p. 135

ICD. Other Ustalfs which:

1. Have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *and*

2. Do not have a densic, lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

3. Within 150 cm of the mineral soil surface, *either*

   a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

   b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

Kandiustalfs, p. 131

ICE. Other Ustalfs that have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.

Kanhaplustalfs, p.134

ICF. Other Ustalfs which have *one or more* of the following:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*

2. No densic, lithic, or paralithic contact within 150 cm of the mineral soil surface, *and* an argillic horizon which has *both*:

   a. Within 150 cm of the mineral soil surface, *either*

      (1) No clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

      (2) Five percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction; *and*

   b. *One or more* of the following:

      (1) In the matrix of its lowest subhorizon, a hue of 7.5YR or redder and a chroma of 5 or more; *or*

      (2) In 50 percent or more of its matrix, a hue of 7.5YR or redder, a color value, moist, of 3 or less, and a color value, dry, of 4 or less; *or*

(3) In the matrix of its lowest subhorizon, common or many coarse redox concentrations with a hue of 7.5YR or redder or a chroma of 6 or more, or both; *or*

3. No densic, lithic, or paralithic contact within 50 cm of the mineral soil surface, *and* an argillic horizon which has *both*:

   a. A clayey or clayey-skeletal particle size class throughout one or more subhorizons in its upper part; *and*

   b. At its upper boundary, a clay increase of *either* 20 percent or more (absolute) within a vertical distance of 7.5 cm, *or* of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction.

Paleustalfs, p. 140

ICG. Other Ustalfs that have in *all* horizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodustalfs, p. 146

ICH. Other Ustalfs.

Haplustalfs, p. 124

Durustalfs

ICAA. All Durustalfs (provisionally).

Typic Durustalfs

Haplustalfs

<u>Key to subgroups</u>

ICHA. Haplustalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplustalfs

ICHB. Other Haplustalfs which have *both*:

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. In one or more horizons within 75 cm of the soil mineral surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquertic Haplustalfs

ICHC. Other Haplustalfs that have *both:*

1. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. Saturation with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in [illegible]

tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. *One or both* of the following:

a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, slickensides, or wedge-shaped aggregates, in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; or

b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Torrertic Haplustalfs

ICHE. Other Haplustalfs which have *both*:

1. When neither irrigated nor fallowed to store moisture, *either*:

a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°; *or*

b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. *One or both* of the following:

a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Udertic Haplustalfs

ICHF. Other Haplustalfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haplustalfs

ICHG. Other Haplustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Aquic Arenic Haplustalfs

ICHH. Other Haplustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. An argillic horizon that has a base saturation (by sum of cations) of less than 75 percent throughout.

Aquultic Haplustalfs

ICHI. Other Haplustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haplustalfs

ICHJ. Other Haplustalfs that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haplustalfs

ICHK. Other Haplustalfs which have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons which are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there is either:

   a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

   b. A combination of lamellae (that may or may not be part of the argillic horizon), and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Haplustalfs

ICHL. Other Haplustalfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Haplustalfs

ICHM. Other Haplustalfs which have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more; *and*

2. When neither irrigated nor fallowed to store moisture, have one of the following:

   a. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

Arenic Aridic Haplustalfs

ICHN. Other Haplustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Haplustalfs

ICHO. Other Haplustalfs which have *both*:

1. A calcic horizon with its upper boundary within 100 cm of the mineral soil surface; *and*

2. When neither irrigated nor fallowed to store moisture have one of the following:

a. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Calcidic Haplustalfs

ICHP. Other Haplustalfs which, when neither irrigated nor fallowed to store moisture, have one of the following:

1. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Haplustalfs

ICHQ. Other Haplustalfs that have a CEC of less than 24 cmol(+)/kg clay (by 1N NH_4OAc pH 7) in 50 percent or more *either* of the argillic horizon if less than 100 cm thick, *or* of its upper 100 cm.

Kanhaplic Haplustalfs

ICHR. Other Haplustalfs that have an argillic horizon 35 cm or less thick.

Ochreptic Haplustalfs

ICHS. Other Haplustalfs which have both:

1. A calcic horizon with its upper boundary within 100 cm of the mineral soil surface; *and*

2. When neither irrigated nor fallowed to store moisture, have one of the following:

   a. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 105 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Calcic Udic Haplustalfs

ICHT. Other Haplustalfs that have an argillic horizon with a base saturation (by sum of cations) of less than 75 percent throughout.

Ultic Haplustalfs

ICHU. Other Haplustalfs that have a calcic horizon with its upper boundary within 100 cm of the mineral soil surface.

Calcic Haplustalfs

ICHV. Other Haplustalfs which, when neither irrigated nor fallowed to store moisture, have one of the following:

1. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 105 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Haplustalfs

ICHW. Other Haplustalfs.

Typic Haplustalfs

Kandiustalfs

Key to subgroups

ICDA. Kandiustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Kandiustalfs

ICDB. Other Kandiustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Aquic Arenic Kandiustalfs

ICDC. Other Kandiustalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiustalfs

ICDD. Other Kandiustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiustalfs

ICDE. Other Kandiustalfs which have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. When neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Arenic Aridic Kandiustalfs

ICDF. Other Kandiustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Kandiustalfs

ICDG. Other Kandiustalfs which, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Kandiustalfs

ICDH. Other Kandiustalfs which, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some part for 135 cumulative days or less per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Kandiustalfs

ICDI. Other Kandiustalfs that have in *all* horizons in the upper 100 cm of the argillic or kandic horizon or throughout the entire argillic or kandic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodic Kandiustalfs

ICDJ. Other Kandiustalfs.

Typic Kandiustalfs

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodic Kanhaplustalfs

ICEF. Other Kanhaplustalfs.

Typic Kanhaplustalfs

Natrustalfs

Key to subgroups

ICCA. Natrustalfs which have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

Salidic Natrustalfs

ICCB. Other Natrustalfs that have *all* of the following:

1. Visible crystals of gypsum or other salts more soluble than gypsum or both within 40 cm of the soil surface; *and*

2. When neither irrigated nor fallowed to store moisture, have one of the following:

   a. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

3. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Leptic Torrertic Natrustalfs

ICCC. Other Natrustalfs that have *both* of the following:

1. When neither irrigated nor fallowed to store moisture, have one of the following:

   a. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Torrertic Natrustalfs

ICCD. Other Natrustalfs which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Aquertic Natrustalfs

ICCE. Other Natrustalfs that have *both* of the following:

1. Visible crystals of gypsum or other salts more soluble than gypsum or both within 40 cm of the mineral soil surface; *and*

2. When neither irrigated nor fallowed to store moisture, have one of the following:

   a. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Leptic Natrustalfs

ICCF. Other Natrustalfs that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrustalfs

ICCG. Other Natrustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Natrustalfs

ICCH. Other Natrustalfs that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Aquic Arenic Natrustalfs

ICCI. Other Natrustalfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Natrustalfs

ICCJ. Other Natrustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Natrustalfs

ICCK. Other Natrustalfs which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Natrustalfs

ICCL. Other Natrustalfs that have visible crystals of gypsum or other salts more soluble than gypsum or both within 40 cm of the mineral soil surface.

Leptic Natrustalfs

ICCM. Other Natrustalfs that have *both* of the following:

1. An exchangeable sodium percentage of less than 15 (or a sodium adsorption ratio of less than 13) in 50 percent or more of the natric horizon; *and*

2. When neither irrigated nor fallowed to store moisture, have one of the following:

   a. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Haplargidic Natrustalfs

ICCN. Other Natrustalfs that when neither irrigated nor fallowed to store moisture, have one of the following:

1. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.
Aridic Natrustalfs

ICCO. Other Natrustalfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.
Mollic Natrustalfs

ICCP. Other Natrustalfs.
Typic Natrustalfs

Paleustalfs

Key to subgroups

ICFA. Paleustalfs which have *both*:

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. In one or more horizons within 75 cm of the soil mineral surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquertic Paleustalfs

ICFB. Other Paleustalfs that have *both:*

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

ICFI. Other Paleustalfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Paleustalfs

ICFJ. Other Paleustalfs which have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. When neither irrigated nor fallowed to store moisture, have one of the following:

   a. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Arenic Aridic Paleustalfs

ICFK. Other Paleustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleustalfs

ICFL. Other Paleustalfs that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleustalfs

ICFM. Other Paleustalfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Paleustalfs

ICFN. Other Paleustalfs which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Paleustalfs

ICFO. Other Paleustalfs which have *both*:

1. When neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. A calcic horizon, *either* within 100 cm of the mineral soil surface if the weighted average particle-size class of the upper 50 cm of the argillic horizon is sandy, *or* within 60 cm if it is loamy, *or* within 50 cm if it is clayey, *and* carbonates in all horizons above the calcic horizon.

Calcidic Paleustalfs

ICFP. Other Paleustalfs which, when neither irrigated nor fallowed to store moisture, have:

1. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Paleustalfs

Rhodustalfs

Key to subgroups

ICGA. Rhodustalfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodustalfs

ICGB. Other Rhodustalfs that have a CEC of less than 24 cmol(+) per kg clay (by 1N NH_4OAc pH 7) in 50 percent or more *either* of the argillic horizon if less than 100 cm thick, *or* of its upper 100 cm.

Kanhaplic Rhodustalfs

ICGC. Other Rhodustalfs which, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Rhodustalfs

ICGD. Other Rhodustalfs.

Typic Rhodustalfs

Xeralfs

Key to great groups

IDA. Xeralfs which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Durixeralfs, p. 148

IDB. Other Xeralfs that have a natric horizon.

Natrixeralfs, p. 154

IDC. Other Xeralfs that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.

Fragixeralfs, p. 149

IDD. Other Xeralfs that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.

Plinthoxeralfs, p. 158

Durixeralfs

Key to subgroups

IDAA. Durixeralfs that have a natric horizon.
Natric Durixeralfs

IDAB. Other Durixeralfs which have, above the duripan, *one or both* of the following:

1. Cracks that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick; *or*

2. A linear extensibility of 6.0 cm or more.
Vertic Durixeralfs

IDAC. Other Durixeralfs that have, in one or more subhorizons within the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Durixeralfs

IDAD. Other Durixeralfs which have *both*:

1. An argillic horizon that has *both*:

   a. A clayey particle size throughout some subhorizon 7.5 cm or more thick; *and*

   b. At its upper boundary or within some part, a clay increase *either* of 20 percent or more (absolute) within a vertical distance of 7.5 cm, *or* of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction; *and*

2. A duripan that is not indurated in any subhorizon.
Abruptic Haplic Durixeralfs

IDAE. Other Durixeralfs which have an argillic horizon that has *both*:

1. A clayey particle size throughout some subhorizon 7.5 cm or more thick; *and*

2. At its upper boundary or within some part, a clay increase *either* of 20 percent or more (absolute) within a vertical distance of 7.5 cm, *or* of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction.
Abruptic Durixeralfs

IDAF. Other Durixeralfs which have a duripan that is not indurated in any subhorizon.

Haplic Durixeralfs

IDAG. Other Durixeralfs.

Typic Durixeralfs

Fragixeralfs

Key to subgroups

IDCA. Fragixeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Fragixeralfs

IDCB. Other Fragixeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Fragixeralfs

IDCC. Other Fragixeralfs that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Mollic Fragixeralfs

IDCD. Other Fragixeralfs that have, in one or more horizons within 40 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Fragixeralfs

IDCE. Other Fragixeralfs that do not, above the fragipan, have an argillic horizon with clay films on both vertical and horizontal faces of any peds.

Ochreptic Fragixeralfs

IDCF. Other Fragixeralfs.

Typic Fragixeralfs

Haploxeralfs

Key to subgroups

IDGA. Haploxeralfs that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. A color value, moist, of 3 or less and 0.7 percent or more organic carbon, either throughout an Ap horizon or throughout the upper 10 cm of an A horizon.

Lithic Mollic Haploxeralfs

IDGB. Other Haploxeralfs which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon that is discontinuous horizontally in each pedon.

Lithic Ruptic-Xerochreptic Haploxeralfs

IDGC. Other Haploxeralfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxeralfs

IDGD. Other Haploxeralfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haploxeralfs

IDGE. Other Haploxeralfs which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a

chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

   a. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

   b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   c. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

      (1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

      (2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Haploxeralfs

IDGF. Other Haploxeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haploxeralfs

IDGG. Other Haploxeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haploxeralfs

IDGH. Other Haploxerolls that have *both*:

1. Fragic soil properties;

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

   a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

   b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.

Fragiaquic Haploxeralfs

IDGI. Other Haploxeralfs which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. An argillic horizon that has a base saturation (by sum of cations) of less than 75 percent in one or more subhorizons within its upper 75 cm or above a densic, lithic, or paralithic contact, whichever is shallower.

Aquultic Haploxeralfs

IDGJ. Other Haploxeralfs that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haploxeralfs

IDGK. Other Haploxeralfs that have an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) in one or more subhorizons of the argillic horizon.

Natric Haploxeralfs

IDGL. Other Haploxeralfs that have fragic soil properties;

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick

Fragic Haploxeralfs

IDGM. Other Haploxeralfs which have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons which are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there is either:

   a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

   b. A combination of lamellae (that may or may not be part of the argillic horizon), and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Haploxeralfs

IDGN. Other Haploxeralfs that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Haploxeralfs

IDGO. Other Haploxeralfs that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Haploxeralfs

IDGP. Other Haploxeralfs which have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calcic Haploxeralfs

Palexeralfs

Key to subgroups

IDFA. Palexeralfs which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Palexeralfs

IDFB. Other Palexeralfs which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

   a. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

   b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   c. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

      (1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

      (2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Palexeralfs

IDFC. Other Palexeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Palexeralfs

IDFD. Other Palexeralfs that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one* or *both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Palexeralfs

IDFE. Other Palexeralfs that have *both*:

1. Fragic soil properties:

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Redox depletions with a chroma of 2 or less in layers that also have aquic conditions in most years (or artificial drainage) *either*:

   a. Within the upper 25 cm of the argillic horizon if its upper boundary is within 50 cm of the mineral soil surface; *or*

   b. Within 75 cm of the mineral soil surface if the upper boundary of the argillic horizon is 50 cm or more below the mineral soil surface.

Fragiaquic Palexeralfs

Rhodoxeralfs

Key to subgroups

IDEA. Rhodoxeralfs that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodoxeralfs

IDEB. Other Rhodoxeralfs which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Rhodoxeralfs

IDEC. Other Rhodoxeralfs which have a calcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Calcic Rhodoxeralfs

IDED. Other Rhodoxeralfs which have an argillic horizon that is either less than 15 cm thick or is discontinuous horizontally in each pedon.

Ochreptic Rhodoxeralfs

IDEE. Other Rhodoxeralfs.

Typic Rhodoxeralfs

CHAPTER 6

ANDISOLS[1]

Key to Suborders

CA. Andisols that have *either*:

1. A histic epipedon; *or*

2. In a layer above a densic, lithic, or paralithic contact or in a layer between 40 and 50 cm either from the mineral soil surface or from the top of an organic layer with andic soil properties, whichever is shallowest, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

a. Two percent or more redox concentrations; or

b. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

c. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquands, p. 162

CB. Other Andisols that have a cryic or pergelic soil temperature regime.

Cryands, p. 168

CC. Other Andisols that have an aridic moisture regime.

Torrands, p. 174

CD. Other Andisols that have a xeric moisture regime.

Xerands, p. 200

CE. Other Andisols that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of less than 30 percent on undried samples, throughout 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no

---

[1] This chapter builds on the preliminary Andisol Proposal (1978) by Guy D. Smith (NZ Soil Bureau Record 96) and represents the work of the International Committee on the Classification of Andisols (ICOMAND), chaired by Michael L. Leamy, New Zealand Soil Bureau.

densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

2. Between either the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, duripan, or petrocalcic horizon.
Vitrands, p. 198

CF. Other Andisols that have an ustic moisture regime.
Ustands, p. 194

CG. Other Andisols.
Udands, p. 175

AQUANDS

Key to great groups

CAA. Aquands that have a cryic or pergelic soil temperature regime.
Cryaquands, p. 163

CAB. Other Aquands that have, in half or more of each pedon, a placic horizon within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.
Placaquands, p. 167

CAC. Other Aquands that have, in 75 percent or more of each pedon, a cemented layer which does not slake in water after air-drying and which has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.
Duraquands, p. 163

CAD. Other Aquands that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of less than 30 percent on undried samples, throughout 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

2. Between either the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, duripan, or petrocalcic horizon.
Vitraquands, p. 168

CAE. Other Aquands that have a melanic epipedon.
Melanaquands, p. 166

CAF. Other Aquands that have episaturation.
Epiaquands, p. 165

CAG. Other Aquands.
Endoaquands, p. 164

Cryaquands

Key to subgroups

CAAA. Cryaquands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.
Lithic Cryaquands

CAAB. Other Cryaquands that have a mean annual soil temperature of 0°C or lower.
Pergelic Cryaquands

CAAC. Other Cryaquands that have a histic epipedon.
Histic Cryaquands

CAAD. Other Cryaquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.
Thaptic Cryaquands

CAAE. Other Cryaquands.
Typic Cryaquands

Duraquands

Key to subgroups

CACA. Duraquands that have a histic epipedon.
Histic Duraquands

CACB. Other Duraquands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.
Acraquoxic Duraquands

CACC. Other Duraquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Duraquands

CACD. Other Duraquands.

Typic Duraquands

Endoaquands

Key to subgroups

CAGA. Endoaquands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Endoaquands

CAGB. Other Endoaquands that have a petroferric contact within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Petroferric Endoaquands

CAGC. Other Endoaquands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Endoaquands

CAGD. Other Endoaquands that have a histic epipedon.

Histic Endoaquands

CAGE. Other Endoaquands that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Endoaquands

CAGF. Other Endoaquands that have, undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Endoaquands

CAGG. Other Endoaquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Endoaquands

CAGH. Other Endoaquands.

Typic Endoaquands

Epiaquands

Key to subgroups

CAFA. Epiaquands that have a petroferric contact within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Petroferric Epiaquands

CAFB. Other Epiaquands that have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Epiaquands

CAFC. Other Epiaquands that have a histic epipedon.

Histic Epiaquands

CAFD. Other Epiaquands that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Epiaquands

CAFE. Other Epiaquands that have, undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Epiaquands

CAFF. Other Epiaquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Epiaquands

CAFG. Other Epiaquands.

Typic Epiaquands

Melanaquands

Key to subgroups

CAEA. Melanaquands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Melanaquands

CAEB. Other Melanaquands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Acraquoxic Melanaquands

CAEC. Other Melanaquands that have *both*:

1. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. More than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Pachic Melanaquands

CAED. Other Melanaquands that have, undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Melanaquands

CAEE. Other Melanaquands that have, between 40 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Melanaquands

CAEF. Other Melanaquands.

Typic Melanaquands

Placaquands

Key to subgroups

CABA. Placaquands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Placaquands

CABB. Other Placaquands which have *both*:

1. A histic epipedon; *and*

2. A horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Histic Placaquands

CABC. Other Placaquands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Placaquands

CABD. Other Placaquands that have a histic epipedon.

Histic Placaquands

CABE. Other Placaquands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick

CBB. Other Cryands that have a melanic epipedon.
Melanocryands, p. 172

CBC. Other Cryands which have a layer that meets the depth, thickness, and organic-carbon requirements of a melanic epipedon.
Fulvicryands, p. 169

CBD. Other Cryands that have, undried, a 1500-kPa water retention of 100 percent or more, on the weighted average, throughout *either*:

1. One or more layers with a total thickness of 35 cm between the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower, and 100 cm from the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

2. Sixty percent or more of the horizon thickness between either the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, duripan, or petrocalcic horizon.
Hydrocryands, p. 171

CBE. Other Cryands that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of less than 30 percent on undried samples, throughout 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

2. Between either the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, duripan, or petrocalcic horizon.
Vitricryands, p. 173

CBF. Other Cryands.
Haplocryands, p. 170

Fulvicryands

Key to subgroups

CBCA. Fulvicryands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.
Lithic Fulvicryands

CBCB. Other Fulvicryands that have 1500 kPa water retention of less than 15 percent on air-dried samples or of less than 30 percent on undried samples throughout one or more layers with andic properties that have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Fulvicryands

CBCC. Other Fulvicryands.

Typic Fulvicryands

Gelicryands

Key to subgroups

CBAA. All Gelicryands.

Typic Gelicryands

Haplocryands

Key to subgroups

CBFA. Haplocryands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Haplocryands

CBFB. Other Haplocryands that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Haplocryands

CBFC. Other Haplocryands that have, in some subhorizon between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Haplocryands

CBFD. Other Haplocryands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Haplocryands

CBFE. Other Haplocryands that have 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Haplocryands

CBFF. Other Haplocryands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Haplocryands

CBFG. Other Haplocryands that have a xeric moisture regime.

Xeric Haplocryands

CBFH. Other Haplocryands.

Typic Haplocryands

Hydrocryands

Key to subgroups

CBDA. Hydrocryands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Hydrocryands

CBDB. Other Hydrocryands that have a placic horizon within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Placic Hydrocryands

CBDC. Other Hydrocryands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Hydrocryands

CBDD. Other Hydrocryands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Hydrocryands

CBDE. Other Hydrocryands.

Typic Hydrocryands

Melanocryands

Key to subgroups

CBBA. Melanocryands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Melanocryands

CBBB. Other Melanocryands that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Alic Melanocryands

CBBC. Other Melanocryands that have 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Melanocryands

CBBD. Other Melanocryands.

Typic Melanocryands

Vitricryands

Key to subgroups

CBEA. Vitricryands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Vitricryands

CBEB. Other Vitricryands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Vitricryands

CBEC. Other Vitricryands that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Vitricryands

CBED. Other Vitricryands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Vitricryands

CCAC. Other Vitritorrands which have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm of the mineral soil surface.

Duric Vitritorrands

CCAD. Other Vitritorrands that have, in one or more horizons between 50 and 100 cm from the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Vitritorrands

CCAE. Other Vitritorrands which have a calcic horizon that has its upper boundary within 125 cm of the mineral soil surface.

Calcic Vitritorrands

CCAF. Other Vitritorrands.

Typic Vitritorrands

Udands

Key to great groups

CGA. Udands that have, in half or more of each pedon, a placic horizon within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Placudands, p. 192

CGB. Other Udands that have, in 75 percent or more of each pedon, a cemented layer which does not slake in water after air-drying and which has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Durudands, p. 176

CGC. Other Udands that have a melanic epipedon.

Melanudands, p. 187

surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Durudands

CGBC. Other Durudands that have *both*:

1. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. More than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Pachic Durudands

CGBD. Other Durudands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Durudands

CGBE. Other Durudands.

Typic Durudands

Fulvudands

Key to subgroups

CGDA. Fulvudands that have *both*:

1. A lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Lithic Fulvudands

CGDB. Other Fulvudands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Fulvudands

Hapludands

Key to subgroups

CGFA. Hapludands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Hapludands

CGFB. Other Hapludands that have a petroferric contact within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Petroferric Hapludands

CGFC. Other Hapludands that have anthraquic conditions.

Anthraquic Hapludands

CGFD. Other Hapludands which have *both:*

1. A horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. In one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

   a. Two percent or more redox concentrations; *or*

   b. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

   c. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Duric Hapludands

CGFE. Other Hapludands that have a horizon 15 cm or more thick, with 20 percent or more (by volume) cemented soil material that does not slake in water after air-drying, that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Duric Hapludands

horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Acrudoxic Thaptic Hapludands

CGFJ. Other Hapludands that have *both:*

1. Extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. An argillic or a kandic horizon that has *both*:

   a. An upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

   b. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Acrudoxic Ultic Hapludands

CGFK. Other Hapludands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Acrudoxic Hapludands

CGFL. Other Hapludands that have 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that have a total thickness of 25 cm or more within 100 cm either of either the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Hapludands

CGFM. Other Hapludands that have *both*:

1. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower,

a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Hydric Thaptic Hapludands

CGFN. Other Hapludands that have, undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Hapludands

CGFO. Other Hapludands that have *both*:

1. A sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more between 25 and 75 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Eutric Thaptic Hapludands

CGFP. Other Hapludands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Hapludands

CGFQ. Other Hapludands that have a sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more between 25 and 75 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Eutric Hapludands

CGFR. Other Hapludands which have an oxic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Oxic Hapludands

CGFS. Other Hapludands which have an argillic or a kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Ultic Hapludands

CGFT. Other Hapludands which have an argillic or a kandic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Hapludands

CGFU. Other Hapludands.

Typic Hapludands

Hydrudands

Key to subgroups

CGEA. Hydrudands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Hydrudands

CGEB. Other Hydrudands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

CGEG. Other Hydrudands which have an argillic or a kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Ultic Hydrudands

CGEH. Other Hydrudands.

Typic Hydrudands

Melanudands

<u>Key to subgroups</u>

CGCA. Melanudands that have a lithic contact within 50 cm *either of the mineral soil surface, or of the top of* an organic layer with andic soil properties, whichever is shallower.

Lithic Melanudands

CGCB. Other Melanudands that have anthraquic conditions.

Anthraquic Melanudands

CGCC. Other Melanudands that have *both*:

1. More than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction of one or more horizons with a total thickness of 10 cm or more, between 25 and 50 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. In one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

   a. Two percent or more redox concentrations; *or*

   b. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

   c. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Alic Aquic Melanudands

CGCK. Other Melanudands that have *both:*

1. More than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. A 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Vitric Melanudands

CGCL. Other Melanudands that have *both:*

1. A sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more between 25 and 75 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. A 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Eutric Vitric Melanudands

CGCM. Other Melanudands that have 1500 kPa water retention of less than 15 percent on air-dried samples *or* of less than 30 percent on undried samples throughout one or more layers with andic soil properties that have a total thickness of 25 cm or more within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Vitric Melanudands

CGCN. Other Melanudands that have *both:*

1. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

CGCS. Other Melanudands which have an argillic or a kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.
Ultic Melanudands

CGCT. Other Melanudands.
Typic Melanudands

Placudands

Key to subgroups

CGAA. Placudands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.
Lithic Placudands

CGAB. Other Placudands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.
Aquic Placudands

CGAC. Other Placudands that have *both*:

1. Extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 2.0 cmol(+)/kg in the fine-earth fraction of one or more horizons with a total thickness of 30 cm or more, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. Undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick

CGAH. Other Placudands that have more than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Placudands

CGAI. Other Placudands that have, undried, a 1500-kPa water retention of 70 percent or more throughout a layer 35 cm or more thick within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Hydric Placudands

CGAJ. Other Placudands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Placudands

CGAK. Other Placudands that have a sum of extractable bases of more than 25.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 15 cm or more between 25 and 75 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower.

Eutric Placudands

CGAL. Other Placudands.

Typic Placudands

Ustands

Key to great groups

CFA. Ustands which have a duripan that has its upper boundary within 100 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Durustands, p. 195

CFB. Other Ustands.

Haplustands, p. 195

Durustands

Key to subgroups

CFAA. Durustands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Durustands

CFAB. Other Durustands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Durustands

CFAC. Other Durustands that have a melanic, mollic, or an umbric epipedon.

Humic Durustands

CFAD. Other Durustands.

Typic Durustands

Haplustands

Key to subgroups

CFBA. Haplustands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Haplustands

CFBB. Other Haplustands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shal-

whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Haplustands

CFBG. Other Haplustands which have a calcic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Calcic Haplustands

CFBH. Other Haplustands that have extractable bases plus 1N-KCl-extractable Al^{3+} totaling less than 15.0 cmol(+)/kg in the fine-earth fraction throughout one or more horizons with a total thickness of 60 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Dystric Haplustands

CFBI. Other Haplustands which have an oxic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Oxic Haplustands

CFBJ. Other Haplustands which have an argillic or a kandic horizon that has *both*:

1. An upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm or the entire argillic horizon, if it is less than 50 cm thick.

Ultic Haplustands

CFBK. Other Haplustands which have an argillic or a kandic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Haplustands

CFBL. Other Haplustands that have a melanic, mollic, or an umbric epipedon.

Humic Haplustands

CEBD. Other Udivitrands which have *both*:

1. An argillic or a kandic horizon that has its upper boundary within 125 cm of the mineral soil surface, or of the upper boundary of an organic layer with andic soil properties, whichever is shallower; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout the upper 50 cm of the argillic or kandic horizon.

Ultic Udivitrands

CEBE. Other Udivitrands which have an argillic or a kandic horizon that has its upper boundary within 125 cm of the mineral soil surface, or of the upper boundary of an organic layer with andic soil properties, whichever is shallower.

Alfic Udivitrands

CEBF. Other Udivitrands that have a melanic, a mollic, or an umbric epipedon.

Humic Udivitrands

CEBG. Other Udivitrands.

Typic Udivitrands

Ustivitrands

Key to subgroups

CEAA. Ustivitrands that have a lithic contact within 50 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Lithic Ustivitrands

CEAB. Other Ustivitrands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Ustivitrands

CEAC. Other Ustivitrands that have, between 25 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Ustivitrands

CEAD. Other Ustivitrands which have a calcic horizon that has its upper boundary within 125 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Calcic Ustivitrands

CEAE. Other Ustivitrands that have a melanic, mollic, or an umbric epipedon.

Humic Ustivitrands

CEAF. Other Ustivitrands.

Typic Ustivitrands

Xerands

Key to great groups

CDA. Xerands that have a 1500-kPa water retention of less than 15 percent on air-dried samples *and* of less than 30 percent on undried samples, throughout 60 percent or more of the thickness *either*:

1. Within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

2. Between either the mineral soil surface, or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact, duripan, or petrocalcic horizon.

Vitrixerands, p. 202

CDB. Other Xerands that have a melanic epipedon.

Melanoxerands, p. 202

CDC. Other Xerands.

Haploxerands, p. 201

Haploxerands

Key to subgroups

CDCA. Haploxerands that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxerands

CDCB. Other Haploxerands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. Two percent or more redox concentrations; *or*

2. A color value, moist, of 4 or more, and 50 percent or more chroma of 2 or less either in redox depletions on faces of peds, or in the matrix if peds are absent; *or*

3. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Haploxerands

CDCC. Other Haploxerands that have, between 25 and 100 cm from the mineral soil surface, a layer 10 cm or more thick with more than 3.0 percent organic carbon and colors of a mollic epipedon throughout, underlying one or more horizons with a total thickness of 10 cm or more that have a color value, moist, 1 unit or more higher and an organic-carbon content 1 percent or more (absolute) lower.

Thaptic Haploxerands

CDCD. Other Haploxerands which have a calcic horizon that has its upper boundary within 125 cm of the mineral soil surface.

Calcic Haploxerands

CDCE. Other Haploxerands which have an argillic or a kandic horizon that has *both*:

1. An upper boundary within 125 cm of the mineral soil surface; *and*

2. A base saturation (by sum of cations) of less than 35 percent throughout its upper 50 cm.

Ultic Haploxerands

CDCF. Other Haploxerands which have *both:*

1. A mollic or an umbric epipedon; *and*

2. An argillic or a kandic horizon that has its upper boundary within 125 cm of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Alfic Humic Haploxerands

CDCG. Other Haploxerands which have an argillic or a kandic horizon that has its upper boundary within 125 cm of the mineral soil surface.

Alfic Haploxerands

CDCH. Other Haploxerands that have a mollic or an umbric epipedon.

Humic Haploxerands

CDCI. Other Haploxerands.

Typic Haploxerands

Melanoxerands

Key to subgroups

CDBA. Melanoxerands that have more than 6.0 percent organic carbon and colors of a mollic epipedon throughout a layer 50 cm or more thick within 60 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Pachic Melanoxerands

CDBB. Other Melanoxerands.

Typic Melanoxerands

Vitrixerands

Key to subgroups

CDAA. Vitrixerands that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Vitrixerands

CDAB. Other Vitrixerands that have, in one or more horizons between 50 and 100 cm either from the mineral soil surface, or from the top of an organic layer with andic soil properties, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5°C or higher at a depth of 50 cm and the soil moisture regime borders a xeric regime.

Xerertic Calciargids

FEEC. Other Calciargids which have *both*:

1. One or both of the following:

   a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or to a densic, lithic, or paralithic contact, if shallower; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5°C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Ustertic Calciargids

FEED. Other Calciargids that have one or both of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; or

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or to a densic, lithic, or paralithic contact, if shallower.

Vertic Calciargids

FEEE. Other Calciargids that are either:

1. Irrigated and have aquic conditions, for some time in most years, in one or more layers within 100 cm of the soil surface; or

2. Saturated with water, in one or more layers within 100 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Aquic Calciargids

FEEF. Other Calciargids which have:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the soil surface to the top of an argillic horizon at a depth of 50 cm or more; and

2. A moisture control section that is dry in all its parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and the moisture regime borders on an ustic regime.

Arenic Ustic Calciargids

FEEG. Other Calciargids which have a sandy or sandy-skeletal particle-size class throughout a layer extending from the soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Calciargids

FEEH. Other Calciargids that have the following combination of characteristics:

1. One or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture resistance class when moist; and

2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders on a xeric regime.

Durinodic Xeric Calciargids

FEEI. Other Calciargids which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture resistance class when moist.

Durinodic Calciargids

FEEJ. Other Calciargids which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Calciargids

FEEK. Other Calciargids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Calciargids

FEEL. Other Calciargids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Calciargids

FEEM. Other Calciargids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders on a xeric regime.

Xeric Calciargids

FEEN. Other Calciargids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders on an ustic regime.

Ustic Calciargids

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.
Vitrandic Gypsiargids

FEDE. Other Gypsiargids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders on a xeric regime.
Xeric Gypsiargids

FEDF. Other Gypsiargids that are dry in all parts of the moisture control section for less then three-fourths of the time (cumulative) that the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders on an ustic regime.
Ustic Gypsiargids

FEDG. Other Gypsiargids.
Typic Gypsiargids

Haplargids

Key to subgroup

FEFA. Haplargids which have:

1. A lithic contact within 50 cm of the soil surface; and

2. An argillic horizon that is discontinuous throughout each pedon.
Lithic Ruptic-Entic Haplargids

FEFB. Other Haplargids which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the soil moisture regime borders on a xeric regime.
Lithic Xeric Haplargids

FEFC. Other Haplargids which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders on an ustic regime.

Lithic Ustic Haplargids

FEFD. Other Haplargids which have a lithic contact within 50 cm of the soil surface.

Lithic Haplargids

FEFE. Other Haplargids which have both:

1. One or both of the following:

   a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or to a densic, lithic, or paralithic contact, if shallower; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5°C or higher at a depth of 50 cm and the moisture regime borders on a xeric regime.

Xerertic Haplargids

FEFF. Other Haplargids which have both:

1. One or both of the following:

   a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or to a densic, lithic, or paralithic contact, if shallower; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5°C or higher at a depth of 50 cm and the moisture regime borders on an ustic regime.

Ustertic Haplargids

FEFG. Other Haplargids that have one or both of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or to a densic, lithic, or paralithic contact, if shallower.

Vertic Haplargids

FEFH. Other Haplargids that are either:

1. Irrigated and have aquic conditions, for some time in most years, in one or more layers within 100 cm of the soil surface; *or*

2. Saturated with water, in one or more layers within 100 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Aquic Haplargids

FEFI. Other Haplargids which have:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the soil surface to the top of an argillic horizon at a depth of 50 cm or more; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and the moisture regime borders an ustic regime.

Arenic Ustic Haplargids

FEFJ. Other Haplargids which have a sandy or sandy-skeletal particle-size class throughout a layer extending from the soil surface to the top of an argillic horizon at a depth of 50 cm or more.

Arenic Haplargids

FEFK. Other Haplargids which have:

1. One or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture resistance class when moist; *and*

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Durinodic Xeric Haplargids

FEFL. Other Haplargids that have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture resistance class when moist.

Durinodic Haplargids

FEFM. Other Haplargids which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) nodules or concretions.

Petronodic Haplargids

FEFN. Other Haplargids that have *both:*

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one* or *both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Haplargids

FEFO. Other Haplargids that which have throughout one or more horizons with a total thickness of 18 cm or

when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Lithic Ustic Natrargids

FEBC. Other Natrargids that have a lithic contact within 50 cm of the soil surface.

Lithic Natrargids

FEBD. Other Natrargids which have one or both of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, slickensides, or wedge-shaped aggregates, in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrargids

FEBE. Other Natrargids that are either:

1. Irrigated and have aquic conditions, for some time in most years, in one or more layers within 100 cm of the soil surface; *or*

2. Saturated with water, in one or more layers within 100 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Aquic Natrargids

FEBF. Other Natrargids that have both of the following:

1. One or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture resistance class when moist; *and*

2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Durinodic Xeric Natrargids

FEBG. Other Natrargids that have one or more horizons, within 100 cm of the soil surface, that have a

b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Paleargids

FECJ. Other Paleargids that have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Paleargids

FECK. Other Paleargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5°C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Xeric Paleargids

FECL. Other Paleargids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Ustic Paleargids

FECM. Other Paleargids.

Typic Paleargids

Petroargids

Key to subgroups

FEAA. Petroargids which have both of the following:

1. A petrogypsic horizon that has its upper boundary within 150 cm of the soil surface; and

2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Petrogypsic Ustic Petroargids

FEAB. Other Petroargids which have a petrogypsic horizon that has its upper boundary within 150 cm of the soil surface.

Petrogypsic Petroargids

FEAC. Other Petroargids which have:

1. A duripan that has its upper boundary within 150 cm of the soil surface; and

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Duric Xeric Petroargids

FEAD. Other Petroargids which have a duripan that has its upper boundary within 150 cm of the soil surface.

Duric Petroargids

FEAE. Other Petroargids which have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the soil moisture regime borders a xeric regime.

Xeric Petroargids

FEAF. Other Petroargids which have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Ustic Petroargids

FEAG. Other Petroargids.

Typic Petroargids

Calcids

Key to great groups

FFA. Calcids which have a petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

Petrocalcids, p. 227

FFB. Other Calcids.

Haplocalcids, p. 223

Haplocalcids

Key to subgroups

FFBA. Haplocalcids that have:

1. A lithic contact within 50 cm of the soil surface; and

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Lithic Xeric Haplocalcids

FFBB. Other Haplocalcids that have:

1. A lithic contact within 50 cm of the soil surface; and

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Lithic Ustic Haplocalcids

FFBC. Other Haplocalcids that have a lithic contact within 50 cm of the soil surface.

Lithic Haplocalcids

FFBD. Other Haplocalcids that have:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, slickensides, or wedge-shaped aggregates, in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; or

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haplocalcids

FFBE. Other Haplocalcids that:

1. Are either:

   a. Irrigated and have aquic conditions, for some time in most years, in one or more layers within 100 cm of the soil surface; *or*

depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Haplocalcids

FFBP. Other Haplocalcids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Haplocalcids

FFBQ. Other Haplocalcids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Xeric Haplocalcids

FFBR. Other Haplocalcids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Ustic Haplocalcids

FFBS. Other Haplocalcids.

Typic Haplocalcids

FFAG. Other Petrocalcids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Petrocalcids

FFAH. Other Petrocalcids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Petrocalcids

FFAI. Other Petrocalcids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Xeric Petrocalcids

FFAJ. Other Petrocalcids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Ustic Petrocalcids

FFAK. Other Petrocalcids

Typic Petrocalcids

Cambids

Key to great groups

FGA. Cambids that are either:

1. Irrigated and have aquic conditions, for some time in most years, in one or more layers within 100 cm of the soil surface; *or*
2. Saturated with water, in one or more layers within 100 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Aquicambids, p. 229

FGB. Other Cambids which have a duripan or a petrocalcic or petrogypsic horizon that has its upper boundary within 150 cm of the soil surface.

Petrocambids, p. 236

FGC. Other Cambids that have an anthropic epipedon.

Anthracambids, p. 229

FGD. Other Cambids.

Haplocambids, p. 231

Anthracambids

Key to subgroups

FGCA. All Anthracambids.

Typic Anthracambids

Aquicambids

Key to subgroups

FGAA. Aquicambids which have a horizon at least 25 cm thick within 100 cm of the soil surface, that have an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least one month of the year in six or more years out of ten.

Sodic Aquicambids

FGAB. Other Aquicambids that have:

1. One or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes or are brittle and have at least a firm rupture resistance class when moist; and
2. Are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative)

Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Aquicambids

FGAG. Other Aquicambids which have an irregular decrease in organic-carbon content from a depth of 25 cm either to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower.

Fluventic Aquicambids

FGAH. Other Aquicambids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders xeric.

Xeric Aquicambids

FGAI. Other Aquicambids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Ustic Aquicambids

FGAJ. Other Aquicambids.

Typic Aquicambids

Haplocambids

Key to subgroups

FGDA. Haplocambids that have:

1. A lithic contact within 50 cm of the soil surface; and

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Lithic Xeric Haplocambids

FGDB. Other Haplocambids that have:

1. A lithic contact within 50 cm of the soil surface; and

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Lithic Ustic Haplocambids

FGDC. Other Haplocambids that have a lithic contact within 50 cm of the soil surface.

Lithic Haplocambids

FGDD. Other Haplocambids that have:

1. One or both of the following:

   a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; or

   b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or to a densic, lithic, or paralithic contact, if shallower; and

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5°C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Xerertic Haplocambids

FGDE. Other Haplocambids that have:

1. One or both of the following:

   a. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; or

   b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or to a densic, lithic, or paralithic contact, if shallower; and

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5°C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.

Ustertic Haplocambids

FGDF. Other Haplocambids that have at least one of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, slickensides, or

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.
Vitrandic Haplocambids

FGDO. Other Haplocambids that:

1. Are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders a xeric regime; *and*

2. Have an irregular decrease in organic-carbon content from a depth of 25 cm either to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower.
Xerifluventic Haplocambids

FGDP. Other Haplocambids that:

1. Are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders an ustic regime; *and*

2. Have an irregular decrease in organic-carbon content from a depth of 25 cm either to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower.
Ustifluventic Haplocambids

FGDQ. Other Haplocambids which have an irregular decrease in organic-carbon content from a depth of 25 cm either to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower.
Fluventic Haplocambids

FGDR. Other Haplocambids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders a xeric regime.
Xeric Haplocambids

FGDS. Other Haplocambids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders an ustic regime.
Ustic Haplocambids

FGDT. Other Haplocambids.

Typic Haplocambids

Petrocambids

Key to subgroups

FGBA. Petrocambids that have a horizon at least 25 cm thick within 100 cm of the soil surface, which has an exchangeable sodium percentage of 15 or more (or an SAR of 13 or more) during at least one month of the year in 6 or more years out of 10.

Sodic Petrocambids

FGBB. Other Petrocambids which have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

    a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

    b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Petrocambids

FGBC. Other Petrocambids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Petrocambids

FGBD. Other Petrocambids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders a xeric regime.

Xeric Petrocambids

FGBE. Other Petrocambids that are dry in all parts of the moisture control section less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5° C or higher and the moisture regime borders an ustic regime.

Ustic Petrocambids

FGBF. Other Petrocambids

Typic Petrocambids

Cryids

Key to great groups

FAA. Cryids which have a salic horizon that has its upper boundary within 100 cm of the soil surface.

Salicryids, p. 244

FAB. Other Cryids which have a duripan, or a petrocalcic or petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

Petrocryids, p. 243

FAC. Other Cryids which have a gypsic horizon that has its upper boundary within 100 cm of the soil surface.

Gypsicryids, p. 240

FAD. Other Cryids that have an argillic or a natric horizon.

Argicryids p. 238

FAE. Other Cryids which have a calcic horizon that has its upper boundary within 100 cm of the soil surface.

Calcicryids, p. 239

FAF. Other Cryids.

Haplocryids, p. 241

b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.
Vitrixerandic Calcicryids

FAEC. Other Calcicryids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.
Vitrandic Calcicryids

FAED. Other Calcicryids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5°C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.
Xeric Calcicryids

FAEE. Other Calcicryids that are dry in all parts of the moisture control section for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders an ustic regime.
Ustic Calcicryids

FAEF. Other Calcicryids.
Typic Calcicryids

Gypsicryids

Key to Subgroups

FACA. Gypsicryids that have a calcic horizon.
Calcic Gypsicryids

FACB. Other Gypsicryids which have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Gypsicryids

FACC. Other Gypsicryids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Gypsicryids

FACD. Other Gypsicryids.

Typic Gypsicryids

Haplocryids

Key to subgroups

FAFA. Haplocryids that have a lithic contact within 50 cm of the soil surface.

Lithic Haplocryids

FAFB. Other Haplocryids that have one or both of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide throughout a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; or

Salicryids

Key to subgroups

FAAA. Salicryids that are saturated with water in one or more layers within 100 cm of the soil surface for 1 month or more per year in 6 or more out of 10 years.
Aquic Salicryids

FAAB. Other Salicryids.
Typic Salicryids

Durids

Key to great groups

FCA. Durids that have a natric horizon above the duripan.
Natridurids, p. 249

FCB. Other Durids that have an argillic horizon above the duripan.
Argidurids, p. 244

FCC. Other Durids.
Haplodurids, p. 247

Argidurids

Key to subgroups

FCBA. Argidurids which have, above the duripan, one or both of the following:

1. Cracks between the soil surface and the top of the duripan that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, slickensides, or wedge-shaped aggregates, in a layer 15 cm or more thick that has its upper boundary above the duripan; or

2. A linear extensibility of 6.0 cm or more between the soil surface and the top of the duripan.
Vertic Argidurids

FCBB. Other Argidurids that are either:

1. Irrigated and have aquic conditions, for some time in most years, in one or more layers within 100 cm of the soil surface; *or*

2. Saturated with water, in one or more layers within 100 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.
Aquic Argidurids

FCBG. Other Argidurids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Argidurids

FCBH. Other Argidurids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Argidurids

FCBI. Other Argidurids which have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Xeric Argidurids

FCBJ. Other Argidurids which have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher and a moisture regime that borders on an ustic regime.

Ustic Argidurids

FCBK. Other Argidurids.

Typic Argidurids

Haplodurids

Key to subgroups

FCCA. Haplodurids that:

1. Have a duripan that is strongly cemented or less cemented in all subhorizons; and

2. Are either:

   a. Irrigated and have aquic conditions, for some time in most years, in one or more layers within 100 cm of the soil surface; *or*

   b. Saturated with water, in one or more layers within 100 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Aquicambidic Haplodurids

FCCB. Other Haplodurids that are either:

1. Irrigated and have aquic conditions, for some time in most years, in one or more layers within 100 cm of the soil surface; *or*

2. Saturated with water, in one or more layers within 100 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Aquic Haplodurids

FCCC. Other Haplodurids that have:

1. A duripan that is strongly cemented or less cemented in all subhorizons; and

2. A mean annual soil temperature lower than 22° C, a difference of 5° C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and a moisture regime that borders on a xeric regime.

Xerochreptic Haplodurids

FCCD. Other Haplodurids that have a duripan that is strongly cemented or less cemented in all subhorizons.

Cambidic Haplodurids

FCCE. Other Haplodurids that have:

1. A moisture control section that is dry in all parts for three-fourths of the time (cumulative) or less when the soil temperature at a depth of 50 cm is 5°C or higher and a moisture regime that borders on a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

    a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

    b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Haplodurids

FCCF. Other Haplodurids that have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Haplodurids

FCCG. Other Haplodurids that have a mean annual soil temperature lower than 22° C, a difference of 5° C or more between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface, and a moisture regime that borders on a xeric regime.

Xeric Haplodurids

FCCH. Other Haplodurids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and a moisture regime that borders on an ustic regime.

Ustic Haplodurids

FCCI. Other Haplodurids.

Typic Haplodurids

Natridurids

Key to subgroups

FCAA. Natridurids which have, above the duripan, one or both of the following:

1. Cracks between the soil surface and the top of the duripan that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, slickensides, or wedge-shaped aggregates, in a layer 15 cm or more thick that has its upper boundary above the duripan; or

2. A linear extensibility of 6.0 cm or more between the soil surface and the top of the duripan.

Vertic Natridurids

FCAB. Other Natridurids which have both:

1. A duripan that is strongly cemented or less cemented in all subhorizons; and

2. Either:

   a. Irrigated and have aquic conditions, for some time in most years, in one or more layers within 100 cm of the soil surface; *or*

   b. Saturated with water, in one or more layers within 100 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Aquic Natrargidic Natridurids

FCAC. Other Natridurids that are either:

1. Irrigated and have aquic conditions, for some time in most years, in one or more layers within 100 cm of the soil surface; *or*

2. Saturated with water, in one or more layers within 100 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Aquic Natridurids

FCAD. Other Natridurids that have the following combination of characteristics:

1. Have a duripan that is strongly cemented or less cemented in all subhorizons; and

2. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.

Natraxeralfic Natridurids

FCAE. Other Natridurids that have a duripan that is strongly cemented or less cemented in all subhorizons.
Natrargidic Natridurids

FCAF. Other Natridurids that have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.
Vitrixerandic Natridurids

FCAG. Other Natridurids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.
Vitrandic Natridurids

FCAH. Other Natridurids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime.
Xeric Natridurids

FCAI. Other Natridurids.
Typic Natridurids

Gypsids

Key to great groups

FDA. Gypsids that have a petrogypsic or petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

Petrogypsids, p. 257

FDB. Other Gypsids that have a natric horizon that has its upper boundary within 100 cm of the soil surface.

Natrigypsids, p. 256

FDC. Other Gypsids that have an argillic horizon that has its upper boundary within 100 cm of the soil surface.

Argigypsids, p. 251

FDD. Other Gypsids that have a calcic horizon that has its upper boundary within 100 cm of the soil surface.

Calcigypsids, p. 253

FDE. Other Gypsids.

Haplogypsids, p. 254

Argigypsids

Key to subgroups

FDCA. Argigypsids that have a lithic contact within 50 cm of the soil surface.

Lithic Argigypsids

FDCB. Other Argigypsids which have:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, slickensides, or wedge-shaped aggregates, in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; or

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argigypsids

FDCC. Other Argigypsids that have a calcic horizon overlying the gypsic horizon.

Calcic Argigypsids

FDCH. Other Argigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and a moisture regime that borders an ustic regime.

Ustic Argigypsids

FDCI. Other Argigypsids.

Typic Argigypsids

Calcigypsids

Key to subgroups

FDDA. Calcigypsids that have a lithic contact within 50 cm of the soil surface.

Lithic Calcigypsids

FDDB. Other Calcigypsids which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

Petronodic Calcigypsids

FDDC. Other Calcigypsids which have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

    a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

    b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Calcigypsids

FDDD. Other Calcigypsids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Calcigypsids

FDDE. Other Calcigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and have a moisture regime that borders on a xeric regime.

Xeric Calcigypsids

FDDF. Other Calcigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and have a moisture regime that borders on an ustic regime.

Ustic Calcigypsids

FDDG. Other Calcigypsids.

Typic Calcigypsids

Haplogypsids

Key to subgroups

FDEA. Haplogypsids that have a lithic contact within 50 cm of the soil surface.

Lithic Haplogypsids

FDEB. Other Haplogypsids which have a gypsic horizon that has its upper boundary within 18 cm of the soil surface.

Leptic Haplogypsids

FDEC. Other Haplogypsids that have a horizon at least 25 cm thick within 100 cm of the mineral surface, which has an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) during at least one month of the year in 6 or more years out of 10.

Sodic Haplogypsids

FDED. Other Haplogypsids which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

Petronodic Haplogypsids

FDEE. Other Haplogypsids which have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Haplogypsids

FDEF. Other Haplogypsids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Haplogypsids

FDEG. Other Haplogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and have a moisture regime that borders on a xeric regime.

Xeric Haplogypsids

FDEH. Other Haplogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and have a moisture regime that borders on an ustic regime.

Ustic Haplogypsids

FDEI. Other Haplogypsids.

Typic Haplogypsids

Natrigypsids

Key to subgroups

FDBA. Natrigypsids that have a lithic contact within 50 cm of the soil surface.

Lithic Natrigypsids

FDBB. Other Natrigypsids that have:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, slickensides, or wedge-shaped aggregates, in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; or

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Natrigypsids

FDBC. Other Natrigypsids which have one or more horizons, within 100 cm of the soil surface, that have a combined thickness of 15 cm or more, that contain 20 percent or more (by volume) durinodes, nodules, or concretions.

Petronodic Natrigypsids

FDBD. Other Natrigypsids which have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one* or *both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Natrigypsids

FDBE. Other Natrigypsids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Natrigypsids

FDBF. Other Natrigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and have a moisture regime that borders a xeric regime.

Xeric Natrigypsids

FDBG. Other Natrigypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and have a moisture regime that borders an ustic regime.

Ustic Natrigypsids

FDBH. Other Natrigypsids.

Typic Natrigypsids

Petrogypsids

Key to subgroups

FDAA. Petrogypsids which have a petrocalcic horizon that has its upper boundary within 100 cm of the soil surface.

Petrocalcic Petrogypsids

FDAB. Other Petrogypsids which have a calcic horizon overlying the petrogypsic horizon.

Calcic Petrogypsids

FDAC. Other Petrogypsids which have *both*:

1. A moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature is 5° C or higher at a depth of 50 cm and the moisture regime borders a xeric regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrixerandic Petrogypsids

FDAD. Other Petrogypsids which have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Petrogypsids

FDAE. Other Petrogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and have a moisture regime that borders a xeric regime.

Xeric Petrogypsids

FDAF. Other Petrogypsids that have a moisture control section that is dry in all parts for less than three-fourths of the time (cumulative) when the soil temperature at a depth of 50 cm is 5°C or higher and have a moisture regime that borders an ustic regime.

Ustic Petrogypsids

FDAG. Other Petrogypsids.

Typic Petrogypsids

Salids

Key to great groups

FBA. Salids that are saturated with water in one or more layers within 100 cm of the mineral soil surface for one month or more per year in 6 or more out of 10 years.

Aquisalids, p. 259

FBB. Other Salids.

Haplosalids, p. 259

Aquisalids

Key to subgroups

FBAA. Aquisalids which have a gypsic or petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

Gypsic Aquisalids

FBAB. Other Aquisalids which have a calcic or petrocalcic horizon that has an upper boundary within 100 cm of the soil surface.

Calcic Aquisalids

FBAC. Other Aquisalids.

Typic Aquisalids

Haplosalids

Key to subgroups

FBBA. Haplosalids which have a duripan that has its upper boundary within 100 cm of the soil surface.

Duric Haplosalids

FBBB. Other Haplosalids which have a petrogypsic horizon that has its upper boundary within 100 cm of the soil surface.

Petrogypsic Haplosalids

FBBC. Other Haplosalids which have a gypsic horizon that has its upper boundary within 100 cm of the soil surface.

Gypsic Haplosalids

FBBD. Other Haplosalids which have a calcic horizon that has its upper boundary within 100 cm of the soil surface.

Calcic Haplosalids

FBBE. Other Haplosalids.

Typic Haplosalids

CHAPTER 8

ENTISOLS

Key to suborders

KA. Entisols that have *one or more* of the following:

1. Aquic conditions and sulfidic materials within 50 cm of the mineral soil surface; *or*

2. Permanent saturation with water, and a reduced matrix in all horizons below a depth of 25 cm from the mineral soil surface; *or*

3. In a layer above a densic, lithic, or paralithic contact or in a layer between 40 and 50 cm from the mineral soil surface, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

   a. A texture finer than loamy fine sand *and*, in 50 percent or more of the matrix, *one or more* of the following:

      (1) A chroma of 0; *or*

      (2) A chroma of 1 or less and a color value, moist, of 4 or more; *or*

      (3) A chroma of 2 or less, and redox concentrations; *or*

   b. A texture of loamy fine sand or coarser *and*, in 50 percent or more of the matrix, *one or more* of the following:

      (1) A chroma of 0; *or*

      (2) A hue of 10YR or redder, a color value, moist, of 4 or more, and a chroma of 1; *or*

      (3) A hue of 10YR or redder, a chroma of 2 or less, and redox concentrations; *or*

      (4) A hue of 2.5Y or yellower, a chroma of 3 or less, and distinct or prominent redox concentrations; *or*

      (5) A hue of 2.5Y or yellower and a chroma of 1; *or*

      (6) A hue of 5GY, 5G, 5BG, or 5B; *or*

      (7) Any color if it results from uncoated sand grains; *or*

c. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquents, p. 262

KB. Other Entisols which have, in one or more layers between 25 and 100 cm from the mineral soil surface, 3 percent or more (by volume) fragments of diagnostic horizons that are not arranged in any discernible order.

Arents, p. 269

KC. Other Entisols that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser, in all layers within the control section for the family particle-size class.

Psamments, p. 295

KD. Other Entisols which do not have a densic, lithic, or paralithic contact within 25 cm of the mineral soil surface, and have:

1. A slope of less than 25 percent; *and*

2. *Either* 0.2 percent or more organic carbon[3] at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A mean annual soil temperature above 0°C.

Fluvents, p. 271

KE. Other Entisols.

Orthents, p. 283

Aquents

Key to great groups

KAA. Aquents that have sulfidic materials within 50 cm of the mineral soil surface.

Sulfaquents, p. 269

KAB. Other Aquents that have *both*:

1. An *n* value of more than 0.7, *and* 8 percent or more clay in the fine-earth fraction of all horizons between 20 and 50 cm from the mineral soil surface; *and*

2. A mean annual soil temperature above 0°C.

Hydraquents, p. 268

KAC. Other Aquents that have a cryic soil temperature regime.

Cryaquents, p. 263

KAD. Other Aquents that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser, in all layers within the control section for the family particle-size class.

Psammaquents, p. 268

KAE. Other Aquents that have *either* 0.2 percent or more organic carbon[4] at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower.

Fluvaquents, p. 265

KAF. Other Aquents that have episaturation.

Epiaquents, p. 265

KAG. Other Aquents.

Endoaquents, p. 264

Cryaquents

Key to subgroups

KACA. Cryaquents which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Cryaquents

KACB. Other Cryaquents.

Typic Cryaquents

Endoaquents

Key to subgroups

KAGA. Endoaquents which have, within 100 cm of the mineral soil surface, *one or both* of the following:

1. Sulfidic materials; *or*

2. A horizon 15 cm or more thick that has all the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0.

Sulfic Endoaquents

KAGB. Other Endoaquents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Endoaquents

KAGC. Other Endoaquents that have, in one or more horizons between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, colors in 50 percent or more of the matrix as follows:

1. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

2. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

3. A hue of 5Y and a chroma of 3 or more; *or*

4. A hue of 5Y or redder and a chroma of 2 or more if there are no redox concentrations.

Aeric Endoaquents

KAGD. Other Endoaquents which have *both*:

1. An Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed), *or* the upper soil to a depth of 15 cm, after mixing, has these colors; *and*

2. A base saturation (by NH_4OAc) of less than 50 percent, in some part, within a depth of 100 cm from the mineral soil surface.

Humaqueptic Endoaquents

KAGE. Other Endoaquents which have *either* an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed), *or* the upper soil to a depth of 15 cm, after mixing, has these colors.

Mollic Endoaquents

KAGF. Other Endoaquents.

Typic Endoaquents

Epiaquents

Key to subgroups

KAFA. Epiaquents that have, in one or more horizons between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, colors in 50 percent or more of the matrix as follows:

1. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

2. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

3. A hue of 5Y and a chroma of 3 or more; *or*

4. A chroma of 2 or more if there are no redox concentrations.

Aeric Epiaquents

KAFB. Other Epiaquents which have *both*:

1. An Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed), *or* the upper soil to a depth of 15 cm, after mixing, has these colors; *and*

2. A base saturation (by NH_4OAc) of less than 50 percent, in some part, within a depth of 100 cm from the mineral soil surface.

Humaqueptic Epiaquents

KAFC. Other Epiaquents which have *either* an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed), *or* the upper soil to a depth of 15 cm, after mixing, has these colors.

Mollic Epiaquents

KAFD. Other Epiaquents.

Typic Epiaquents

Fluvaquents

Key to subgroups

KAEA. Fluvaquents which have, within 100 cm of the mineral soil surface, *one or both* of the following:

1. Sulfidic materials; *or*

2. A horizon 15 cm or more thick that has all the characteristics of a sulfuric horizon, except that it has a pH value between 3.5 and 4.0.

Sulfic Fluvaquents

KAEB. Other Fluvaquents which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Fluvaquents

KAEC. Other Fluvaquents which have *both*:

1. A buried Histosol, or a buried histic epipedon, that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. A difference of less than 5°C between mean summer and mean winter soil temperatures, either at a depth of 50 cm from the soil surface or at a densic, lithic, or paralithic contact, whichever is shallower.

Thapto-Histic Tropic Fluvaquents

KAED. Other Fluvaquents which have a buried Histosol, or a buried histic epipedon, that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Fluvaquents

KAEE. Other Fluvaquents which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

KAEI. Other Fluvaquents which have *both*:

1. An Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed), *or* the upper soil to a depth of 15 cm, after mixing, has these colors; *and*

2. A base saturation (by NH_4OAc) of less than 50 percent, in some part, within a depth of 100 cm from the mineral soil surface.

Humaqueptic Fluvaquents

KAEJ. Other Fluvaquents which have *either* an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed), *or* the upper soil to a depth of 15 cm, after mixing, has these colors.

Mollic Fluvaquents

KAEK. Other Fluvaquents.

Typic Fluvaquents

Hydraquents

Key to subgroups

KABA. Hydraquents that have a buried Histosol, or a buried histic epipedon, that has its upper boundary within 100 cm of the mineral surface.

Thapto-Histic Hydraquents

KABB. Other Hydraquents.

Typic Hydraquents

Psammaquents

Key to subgroups

KADA. Psammaquents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Psammaquents

KADB. Other Psammaquents which have a horizon 5 cm or more thick, either below an Ap horizon or at a depth of 18 cm or more from the mineral soil surface, whichever is deeper, that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*

2. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.
Spodic Psammaquents

KADC. Other Psammaquents which have *both*:

1. An Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed), *or* the upper soil to a depth of 15 cm, after mixing, has these colors; *and*

2. A base saturation (by NH_4OAc) of less than 50 percent, in some part, within a depth of 100 cm from the mineral soil surface.
Humaqueptic Psammaquents

KADD. Other Psammaquents which have *either* an Ap horizon that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed), *or* the upper soil to a depth of 15 cm, after mixing, has these colors.
Mollic Psammaquents

KADE. Other Psammaquents.
Typic Psammaquents

Sulfaquents

Key to subgroups

KAAA. Sulfaquents that have a histic epipedon.
Histic Sulfaquents

KAAB. Other Sulfaquents which have *both*:

1. Sulfidic materials that have their upper boundary 30 cm or more below the mineral soil surface; *and*

2. An *n* value of 0.7 or less in one or more horizons between 20 and 50 cm from the mineral soil surface.
Haplic Sulfaquents

KAAC. Other Sulfaquents.
Typic Sulfaquents

Arents

Key to great groups

KBA. Arents that have an ustic moisture regime.
Ustarents, p. 270

KBB. Other Arents that have a xeric moisture regime.
Xerarents, p. 270

KBC. Other Arents that have a torric moisture regime.
Torriarents, p. 270

KBD. Other Arents.
Udarents, p. 270

Torriarents

Torriarents are the Arents that have a torric soil moisture regime.

Udarents

Key to subgroups

KBDA. Udarents that have fragments of an argillic horizon with a base saturation (by sum of cations) of 35 percent or more within 100 cm of the mineral soil surface.
Alfic Udarents

KBDB. Other Udarents that have fragments of an argillic horizon within 100 cm of the mineral soil surface.
Ultic Udarents

KBDC. Other Udarents that have fragments of a mollic epipedon within 100 cm of the mineral soil surface.
Mollic Udarents

KBDD. Other Udarents.
Udarents

Ustarents

Ustarents are the Arents that have an ustic soil moisture regime.

Xerarents

Key to subgroups

KBBA. Xerarents that have fragments of an argillic horizon with a base saturation (by sum of cations) of 35 percent or more within 100 cm of the mineral soil surface.
Alfic Xerarents

KBBB. Other Xerarents.
Xerarents

Fluvents

Key to great groups

KDA. Fluvents that have a cryic soil temperature regime.

Cryofluvents, p. 271

KDB. Other Fluvents that have a xeric moisture regime.

Xerofluvents, p. 281

KDC. Other Fluvents that have an ustic moisture regime.

Ustifluvents, p. 277

KDD. Other Fluvents that have a torric moisture regime.

Torrifluvents, p. 272

KDE. Other Fluvents that have an isomesic, isothermic, or isohyperthermic soil temperature regime.

Tropofluvents, p. 275

KDF. Other Fluvents.

Udifluvents, p. 275

Cryofluvents

Key to subgroups

KDAA. Cryofluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Cryofluvents

KDAB. Other Cryofluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
Vitrandic Cryofluvents

KDAC. Other Cryofluvents that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Cryofluvents

KDAD. Other Cryofluvents that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
Oxyaquic Cryofluvents

KDAE. Other Cryofluvents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).
Mollic Cryofluvents

KDAF. Other Cryofluvents.
Typic Cryofluvents

Torrifluvents

Key to subgroups

KDDA. Torrifluvents which have:

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. A hyperthermic, thermic, mesic, frigid, or an *iso* soil temperature regime, and a torric moisture regime that borders on an ustic regime.
Ustertic Torrifluvents

KDDB. Other Torrifluvents which have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Torrifluvents

KDDC. Other Torrifluvents which have:

1. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime; *and*

3. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

      (1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

      (2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrixerandic Torrifluvents

KDDD. Other Torrifluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

    a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

    b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Torrifluvents

KDDE. Other Torrifluvents that have, in one or more horizons within 100 cm of the soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Torrifluvents

KDDF. Other Torrifluvents that are saturated with water, in one or more layers within 150 cm of the soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Torrifluvents

KDDG. Other Torrifluvents which have:

1. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime.

Duric Xeric Torrifluvents

KDDH. Other Torrifluvents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Duric Torrifluvents

KDDI. Other Torrifluvents which have *both*:

1. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A torric moisture regime that borders on an ustic regime.

Ustic Torrifluvents

KDDJ. Other Torrifluvents which have *both*:

1. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

2. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime.

Xeric Torrifluvents

KDDK. Other Torrifluvents that have an anthropic epipedon.

Anthropic Torrifluvents

KDDL. Other Torrifluvents.

Typic Torrifluvents

Tropofluvents

Key to subgroups

KDEA. All Tropofluvents (provisionally).

Typic Tropofluvents

Udifluvents

Key to subgroups

KDFA. Udifluvents which have both:

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. *Either* or both of the following:

   a. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *or*

b. In one or more horizons within 100 cm of the mineral soil surface, a color value, moist, of 4 or more and either a chroma of 0 or a hue of 5GY, 5G, 5BG, or 5B, and also aquic conditions for some time in most years (or artificial drainage).

Aquertic Udifluvents

KDFB. Other Udifluvents that have *one* or *both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Udifluvents

KDFC. Other Udifluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Udifluvents

KDFD. Other Udifluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Ustifluvents

KDCH. Other Ustifluvents which, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section that is dry, in 6 or more out or 10 years, in some or all parts for less than 105 cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for less than four tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Ustifluvents

KDCI. Other Ustifluvents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Mollic Ustifluvents

KDCJ. Other Ustifluvents.

Typic Ustifluvents

(2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Xerofluvents

KDBC. Other Xerofluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Xerofluvents

KDBD. Other Xerofluvents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Xerofluvents

KDBE. Other Xerofluvents that have *either*:

1. In one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *or*

2. In one or more horizons within 150 cm of the mineral soil surface, a color value, moist, of 4 or more and either a chroma of 0 or a hue of 5GY, 5G, 5BG, or 5B; and also aquic conditions for some time in most years (or artificial drainage).

Aquic Xerofluvents

KDBF. Other Xerofluvents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Xerofluvents

KDBG. Other Xerofluvents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Durinodic Xerofluvents

KDBH. Other Xerofluvents which have an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Mollic Xerofluvents

KDBI. Other Xerofluvents.

Typic Xerofluvents

Orthents

Key to great groups

KEA. Orthents that have a cryic or pergelic soil temperature regime.

Cryorthents, p. 283

KEB. Other Orthents that have a torric moisture regime.

Torriorthents, p. 284

KEC. Other Orthents that have a xeric moisture regime.

Xerorthents, p. 293

KED. Other Orthents that have a udic moisture regime, and a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface.

Troporthents, p. 288

KEE. Other Orthents that have an ustic moisture regime.

Ustorthents, p. 290

KEF. Other Orthents.

Udorthents, p. 289

Cryorthents

Key to subgroups

KEAA. Cryorthents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryorthents

KEAB. Other Cryorthents that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryorthents

KEAC. Other Cryorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Cryorthents

KEAD. Other Cryorthents that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Cryorthents

KEAE. Other Cryorthents that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Cryorthents

KEAF. Other Cryorthents.

Typic Cryorthents

Torriorthents

Key to subgroups

KEBA. Torriorthents which have:

1. A lithic contact within 50 cm of the soil surface; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. A hyperthermic, thermic, mesic, frigid, or an *iso* soil temperature regime, and a torric moisture regime that borders on an ustic regime.

Lithic Ustic Torriorthents

b. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime.

Xerertic Torriorthents

KEBF. Other Torriorthents which have *one or both* of the following:

1. Cracks within 125 cm of the soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Torriorthents

KEBG. Other Torriorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Torriorthents

KEBH. Other Torriorthents that have *both*:

1. In one or more horizons within 100 cm of the soil surface, redox depletions with a chroma of 2 or

ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
Vitrandic Troporthents

KEDD. Other Troporthents.
Typic Troporthents

Udorthents

Key to subgroups

KEFA. Udorthents that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Udorthents

KEFB. Other Udorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.
Andic Udorthents

KEFC. Other Udorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

    a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

    b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
Vitrandic Udorthents

KEFD. Other Udorthents that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Udorthents

KEFE. Other Udorthents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
Oxyaquic Udorthents

KEFF. Other Udorthents that have 50 percent or more (by volume) wormholes, worm casts, and filled animal burrows between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 100 cm or a densic, lithic, paralithic, or petroferric contact, whichever is shallower.

Vermic Udorthents

KEFG. Other Udorthents.

Typic Udorthents

Ustorthents

Key to subgroups

KEEA. Ustorthents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Ustorthents

KEEB. Other Ustorthents which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Ustorthents

KEEC. Other Ustorthents that have anthraquic conditions.

Anthraquic Ustorthents

KEED. Other Ustorthents that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Ustorthents

KEEE. Other Ustorthents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Ustorthents

KEEF. Other Ustorthents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Durinodic Ustorthents

KEEG. Other Ustorthents that have *both*:

1. When neither irrigated nor fallowed to store moisture, *either*:

   a. A frigid temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four-tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter; *and*:

      (1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass; *and*

      (2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitritorrandic Ustorthents

KEEH. Other Ustorthents that have throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Ustorthents

KEEI. Other Ustorthents which, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Ustorthents

KEEJ. Other Ustorthents which, when neither irrigated nor fallowed to store moisture, have *one* of the following:

1. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 105

cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for less than four tenths of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

3. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per years when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Ustorthents

KEEK. Other Ustorthents that have 50 percent or more (by volume) wormholes, worm casts, and filled animal burrows between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 100 cm or a densic, lithic, paralithic, or petroferric contact, whichever is shallower.

Vermic Ustorthents

KEEL. Other Ustorthents.

Typic Ustorthents

Xerorthents

Key to subgroups

KECA. Xerorthents that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Xerorthents

KECB. Other Xerorthents which have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

   a. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

c. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

(1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

(2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Xerorthents

KECC. Other Xerorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Xerorthents

KECD. Other Xerorthents that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Xerorthents

KECE. Other Xerorthents that have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Aquic Durinodic Xerorthents

KECF. Other Xerorthents that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Xerorthents

KECG. Other Xerorthents that are saturated with water, in one or more layers within 150 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Xerorthents

KECH. Other Xerorthents which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Durinodic Xerorthents

KECI. Other Xerorthents that have a base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

Dystric Xerorthents

KECJ. Other Xerorthents.

Typic Xerorthents

Psamments

Key to great groups

KCA. Psamments that have a cryic or pergelic soil temperature regime.

Cryopsamments, p. 296

KCB. Other Psamments that have a torric moisture regime.

Torripsamments, p. 299

KCC. Other Psamments that have, within the particle-size control section, more than 90 percent silica and other extremely durable minerals in the 0.02-to-2.0-mm fraction.

Quartzipsamments, p. 297

KCD. Other Psamments that have a udic moisture regime, and a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface.

Tropopsamments, p. 300

KCE. Other Psamments that have an ustic moisture regime.

Ustipsamments, p. 302

KCF. Other Psamments that have a xeric moisture regime.

Xeropsamments, p. 303

KCG. Other Psamments.

Udipsamments, p.301

Cryopsamments

Key to subgroups

KCAA. Cryopsamments that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryopsamments

KCAB. Other Cryopsamments that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryopsamments

KCAC. Other Cryopsamments that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Cryopsamments

KCAD. Other Cryopsamments that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Cryopsamments

KCAE. Other Cryopsamments that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Cryopsamments

KCAF. Other Cryopsamments which have a horizon 5 cm or more thick that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*

2. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

surface, whichever is deeper, that has *one or more* of the following:

1. In 25 percent or more of each pedon, cementation by organic matter and aluminum, with or without iron; *or*

2. Aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling 0.25 or more, and half that amount or less in an overlying horizon; *or*

3. An ODOE value of 0.12 or more, and a value half as high or lower in an overlying horizon.

Spodic Quartzipsamments

KCCM. Other Quartzipsamments.

Typic Quartzipsamments

Torripsamments

Key to subgroups

KCBA. Torripsamments that have a lithic contact within 50 cm of the soil surface.

Lithic Torripsamments

KCBB. Other Torripsamments that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter of which 5 percent or more is volcanic glass, and [(Al plus 1/2 Fe, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is 30 or more.

Vitrandic Torripsamments

KCBC. Other Torripsamments which have:

1. A horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in all its parts for less than three fourths of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. A thermic, mesic, or frigid soil temperature regime, and a torric moisture regime that borders on a xeric regime.

Duric Xeric Torripsamments

KCBD. Other Torripsamments which have a horizon within 100 cm of the soil surface that is 15 cm or more thick and either contains 20 percent or more (by

KCFH. Other Xeropsamments that have a base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

Dystric Xeropsamments

KCFI. Other Xeropsamments.

Typic Xeropsamments

2. In the *combined* thickness of the organic parts of the surface *and* subsurface tiers if there is a continuous mineral layer 40 cm or more thick that has its upper boundary within the subsurface tier.
Hemists, p. 313

AD. Other Histosols.
Saprists, p. 319

Fibrists

Key to great groups

ABA. Fibrists in which fibric *Sphagnum* constitutes three fourths or more of the volume to *either* a depth of 90 cm or more, *or* to 10 cm or more below the upper boundary of frozen[1] soil materials, *or* to a densic, lithic, or paralithic contact, fragmental materials, or other mineral soil materials.
Sphagnofibrists, p. 310

ABB. Other Fibrists which, in most years, *either*:

1. Are frozen in one or more layers within the control section 2 months after the summer solstice; *or*

2. Never freeze below a depth of 5 cm from the soil surface but have a mean annual soil temperature lower than 8°C.
Cryofibrists, p. 308

ABC. Other Fibrists that have a mean annual soil temperature lower than 8°C.
Borofibrists, p. 307

ABD. Other Fibrists that have a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 30 cm from the soil surface.
Tropofibrists, p. 311

ABE. Other Fibrists that have a horizon 2 cm or more thick in which humilluvic materials constitute one half or more of the volume.
Luvifibrists, p. 309

ABF. Other Fibrists.
Medifibrists, p. 309

---

[1] Frozen 2 months after the summer solstice.

Borofibrists

Key to subgroups

ABCA. Borofibrists that have a layer of water within the control section below the surface tier.

Hydric Borofibrists

ABCB. Other Borofibrists that have a lithic contact within the control section.

Lithic Borofibrists

ABCC. Other Borofibrists which have *both*:

1. Three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Sphagnic Terric Borofibrists

ABCD. Other Borofibrists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Hemic Terric Borofibrists

ABCE. Other Borofibrists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of sapric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Sapric Terric Borofibrists

ABCF. Other Borofibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Borofibrists

ABCG. Other Borofibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Borofibrists

ABCH. Other Borofibrists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Borofibrists

ABCI. Other Borofibrists that have three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*.

Sphagnic Borofibrists

ABCJ. Other Borofibrists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.

Hemic Borofibrists

ABCK. Other Borofibrists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of sapric materials below the surface tier.

Sapric Borofibrists

ABCL. Other Borofibrists.

Typic Borofibrists

Cryofibrists

Key to subgroups

ABBA. Cryofibrists that have a lithic contact within the control section.

Lithic Cryofibrists

ABBB. Other Cryofibrists that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryofibrists

ABBC. Other Cryofibrists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Cryofibrists

ABBD. Other Cryofibrists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Cryofibrists

ABBE. Other Cryofibrists that have three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*.

Sphagnic Cryofibrists

ABBF. Other Cryofibrists.

Typic Cryofibrists

ABFG. Other Medifibrists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Medifibrists

ABFH. Other Medifibrists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Medifibrists

ABFI. Other Medifibrists that have three fourths or more of the fiber volume in the surface tier derived from *Sphagnum*.

Sphagnic Medifibrists

ABFJ. Other Medifibrists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.

Hemic Medifibrists

ABFK. Other Medifibrists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of sapric materials below the surface tier.

Sapric Medifibrists

ABFL. Other Medifibrists.

Typic Medifibrists

Sphagnofibrists

Key to subgroups

ABAA. Sphagnofibrists which:

1. Have a mean annual soil temperature of 0°C or less; *and*

2. In most years, are *either* frozen in one or more layers within the control section 2 months after the summer solstice, *or* freeze to a depth of 5 cm or more below the soil surface.

Pergelic Sphagnofibrists

ABAB. Other Sphagnofibrists that have a layer of water within the control section below the surface tier.

Hydric Sphagnofibrists

ABAC. Other Sphagnofibrists that have a lithic contact within the control section.

Lithic Sphagnofibrists

ABAD. Other Sphagnofibrists which:

1. Have a mean annual soil temperature between 0°C and 8°C; *and*

AAD. Other Folists.

Medifolists, p. 313

Borofolists

Key to subgroups

AACA. Borofolists that have a lithic contact within 100 cm of the soil surface.

Lithic Borofolists

AACB. Other Borofolists.

Typic Borofolists

Cryofolists

Key to subgroups

AAAA. Cryofolists that have a lithic contact within 100 cm of the soil surface.

Lithic Cryofolists

AAAB. Other Cryofolists.

Typic Cryofolists

Medifolists

Key to subgroups

AADA. Medifolists that have a lithic contact within 100 cm of the soil surface.

Lithic Medifolists

AADB. Other Medifolists.

Typic Medifolists

Tropofolists

Key to subgroups

AABA. Tropofolists that have a lithic contact within 100 cm of the soil surface.

Lithic Tropofolists

AABB. Other Tropofolists.

Typic Tropofolists

Hemists

Key to great groups

ACA. Hemists which have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface.

Sulfohemists, p. 317

ACB. Other Hemists that have sulfidic materials within 100 cm of the soil surface.

Sulfihemists, p. 317

ACC. Other Hemists that have a horizon 2 cm or more thick in which humilluvic materials constitute one half or more of the volume.

Luvihemists, p. 316

ACD. Other Hemists which, in most years, *either*:

1. Are frozen in one or more layers within the control section 2 months after the summer solstice; *or*

2. Never freeze below a depth of 5 cm from the soil surface but have a mean annual soil temperature lower than 8°C.

Cryohemists, p. 315

ACE. Other Hemists that have a mean annual soil temperature lower than 8°C.

Borohemists, p. 314

ACF. Other Hemists that have a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 30 cm below the soil surface.

Tropohemists, p. 317

ACG. Other Hemists.

Medihemists, p. 316

Borohemists

Key to subgroups

ACEA. Borohemists that have a layer of water within the control section below the surface tier.

Hydric Borohemists

ACEB. Other Borohemists that have a lithic contact within the control section.

Lithic Borohemists

ACEC. Other Borohemists which have *both*:

1. Other Borohemists that have one or more layers, with a total thickness of 25 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Fibric Terric Borohemists

ACED. Other Borohemists which have *both*:

ACDD. Other Cryohemists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Cryohemists

ACDE. Other Cryohemists.

Typic Cryohemists

Luvihemists

Key to subgroups

ACCA. All Luvihemists (provisionally).

Typic Luvihemists

Medihemists

Key to subgroups

ACGA. Medihemists that have a layer of water within the control section below the surface tier.

Hydric Medihemists

ACGB. Other Medihemists that have a lithic contact within the control section.

Lithic Medihemists

ACGC. Other Medihemists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Fibric Terric Medihemists

ACGD. Other Medihemists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of sapric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Sapric Terric Medihemists

ACGE. Other Medihemists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Medihemists

Saprists

Key to great groups

ADA. Saprists which have a sulfuric horizon that has its upper boundary within 50 cm of the soil surface.
Sulfosaprists, p. 322

ADB. Other Saprists that have sulfidic materials within 100 cm of the soil surface.
Sulfisaprists, p. 322

ADC. Other Saprists which, in most years, *either*:

1. Are frozen in one or more layers within the control section 2 months after the summer solstice; *or*

2. Never freeze below a depth of 5 cm from the soil surface but have a mean annual soil temperature lower than 8°C.

Cryosaprists, p. 320

ADD. Other Saprists that have a mean annual soil temperature lower than 8° C.
Borosaprists, p. 319

ADE. Other Saprists that have less than 5°C difference between mean summer and mean winter soil temperatures at a depth of 30 cm from the soil surface.
Troposaprists, **p. 322**

ADF. Other Saprists.
Medisaprists, p. 321

Borosaprists

Key to subgroups

ADDA. Borosaprists that have a lithic contact within the control section.
Lithic Borosaprists

ADDB. Other Borosaprists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Fibric Terric Borosaprists

ADDC. Other Borosaprists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Hemic Terric Borosaprists

ADDD. Other Borosaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Borosaprists

ADDE. Other Borosaprists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Borosaprists

ADDF. Other Borosaprists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Borosaprists

ADDG. Other Borosaprists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier.

Fibric Borosaprists

ADDH. Other Borosaprists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.

Hemic Borosaprists

ADDI. Other Borosaprists.

Typic Borosaprists

Cryosaprists

Key to subgroups

ADCA. Cryosaprists that have a lithic contact within the control section.

Lithic Cryosaprists

ADCB. Other Cryosaprists that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryosaprists

ADCC. Other Cryosaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Cryosaprists

ADCD. Other Cryosaprists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.
Fluvaquentic Cryosaprists

ADCE. Other Cryosaprists.
Typic Cryosaprists

Medisaprists

Key to subgroups

ADFA. Medisaprists that have a lithic contact within the control section.
Lithic Medisaprists

ADFB. Other Medisaprists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.
Fibric Terric Medisaprists

ADFC. Other Medisaprists which have *both*:

1. One or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.
Hemic Terric Medisaprists

ADFD. Other Medisaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.
Terric Medisaprists

ADFE. Other Medisaprists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.
Limnic Medisaprists

ADFF. Other Medisaprists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.
Fluvaquentic Medisaprists

ADFG. Other Medisaprists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier.
Fibric Medisaprists

ADFH. Other Medisaprists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.
Hemic Medisaprists

ADFI. Other Medisaprists.
Typic Medisaprists

Sulfisaprists

Key to subgroups

ADBA. Sulfisaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.
Terric Sulfisaprists

ADBB. Other Sulfisaprists.
Typic Sulfisaprists

Sulfosaprists

Key to subgroups

ADAA. All Sulfosaprists (provisionally).
Typic Sulfosaprists

Troposaprists

Key to subgroups

ADEA. Troposaprists that have a lithic contact within the control section.
Lithic Troposaprists

ADEB. Other Troposaprists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.
Fibric Terric Troposaprists

ADEC. Other Troposaprists which have *both*:

1. One or more layers, with a total thickness of 12.5 cm or more, consisting of hemic materials below the surface tier; *and*

2. A mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Hemic Terric Troposaprists

ADED. Other Troposaprists which have a mineral layer 30 cm or more thick that has its upper boundary within the control section below the surface tier.

Terric Troposaprists

ADEE. Other Troposaprists that have one or more limnic layers with a total thickness of 5 cm or more within the control section.

Limnic Troposaprists

ADEF. Other Troposaprists that have, within organic materials, either one mineral layer 5 cm or more thick, or two or more mineral layers of any thickness, in the control section below the surface tier.

Fluvaquentic Troposaprists

ADEG. Other Troposaprists that have one or more layers, with a total thickness of 12.5 cm or more, consisting of fibric materials below the surface tier.

Fibric Troposaprists

ADEH. Other Troposaprists that have one or more layers, with a total thickness of 25 cm or more, consisting of hemic materials below the surface tier.

Hemic Troposaprists

ADEI. Other Troposaprists.

Typic Troposaprists

CHAPTER 10

INCEPTISOLS

Key to suborders

JA. Inceptisols which have:

1. In a layer above a densic, lithic, or paralithic contact or in a layer between 40 and 50 cm from the mineral soil surface, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one* or *more* of the following:

   a. A histic epipedon; *or*

   b. A sulfuric horizon that has its upper boundary within 50 cm of the mineral soil surface; *or*

   c. A mollic, an ochric, or an umbric epipedon that is underlain directly, or within 50 cm of the mineral soil surface, by a horizon that has, on faces of peds or in the matrix if peds are absent, 50 percent or more chroma of *either*:

      (1) Two or less if there are redox concentrations; *or*

      (2) One or less; *or*

2. An exchangeable sodium percentage (ESP) of 15 or more (or a sodium adsorption ratio, SAR, of 13 or more) in half or more of the soil volume within 50 cm of the mineral soil surface, and a decrease in ESP (or SAR) values with increasing depth below 50 cm, *and* ground water within 100 cm of the mineral soil surface for some time during the year; *or*

3. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquepts, p. 326

JB. Other Inceptisols that have a plaggen epipedon.

Plaggepts, p. 361

JC. Other Inceptisols that have an isomesic or a warmer *iso* temperature regime.

Tropepts, p. 361

JD. Other Inceptisols that have *either*:

1. An ochric epipedon; *or*

2. A mesic or warmer soil temperature regime and an umbric or a mollic epipedon less than 25 cm thick.

Ochrepts, p. 338

JE. Other Inceptisols.

Umbrepts, p. 370

Aquepts

Key to great groups

JAA. Aquepts which have a sulfuric horizon that has its upper boundary within 50 cm of the mineral soil surface.

Sulfaquepts, p. 336

JAB. Other Aquepts that have, in half or more of each pedon, a placic horizon within 100 cm of the mineral soil surface.

Placaquepts, p.335

JAC. Other Aquepts that have, in one or more horizons with a total thickness of 25 cm or more within 50 cm of the mineral soil surface, either an exchangeable sodium percentage (ESP) of 15 or more (or a sodium adsorption ratio, SAR, of 13 or more), and a decrease in ESP (or SAR) values with increasing depth below 50 cm.

Halaquepts, p. 333

JAD. Other Aquepts that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.

Fragiaquepts, p. 333

JAE. Other Aquepts that have a cryic or pergelic soil temperature regime.

Cryaquepts, p. 327

JAF. Other Aquepts that have one or more horizons within 125 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.

Plinthaquepts, p. 336

JAG. Other Aquepts that have a difference of less than 5°C between mean summer and mean winter soil temperatures either at a depth of 50 cm from the soil surface, or at a densic, lithic, or paralithic contact, whichever is shallower.

Tropaquepts, p. 336

JAH. Other Aquepts that have one or more layers at least 25 cm thick (cumulative) within a depth of 100 cm from the mineral soil surface, which have 25 percent or more (by volume) recognizable bioturbation such as filled animal burrows, wormholes, or casts.
Vermaquepts, p. 338

JAI. Other Aquepts that have a histic, a mollic, or an umbric epipedon.
Humaquepts, p. 334

JAJ. Other Aquepts that have episaturation.
Epiaquepts, p. 331

JAK. Other Aquepts.
Endoaquepts, p. 329

Cryaquepts

Key to subgroups

JAEA. Cryaquepts which have, within 150 cm of the mineral soil surface, *one or more* of the following:

1. A sulfuric horizon; *or*

2. A horizon 15 cm or more thick that has all the characteristics of a sulfuric horizon, except that it has a pH between 3.5 and 4.0; *or*

3. Sulfidic materials.

Sulfic Cryaquepts

JAEB. Other Cryaquepts that have *both* a histic epipedon *and* a lithic contact within 50 cm of the mineral soil surface.
Histic Lithic Cryaquepts

JAEC. Other Cryaquepts that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Cryaquepts

JAED. Other Cryaquepts which have *both*:

1. A histic epipedon that is continuous in each pedon; *and*

2. A mean annual soil temperature of 0°C or lower.

Histic Pergelic Cryaquepts

JAEE. Other Cryaquepts which have *both*:

1. A histic epipedon that is discontinuous in each pedon; *and*

2. A mean annual soil temperature of 0°C or lower.
Pergelic Ruptic-Histic Cryaquepts

JAEF. Other Cryaquepts which have *both*:

1. An umbric epipedon; *and*

2. A mean annual soil temperature of 0°C or lower.
Humic Pergelic Cryaquepts

JAEG. Other Cryaquepts that have a mean annual soil temperature of 0°C or lower.
Pergelic Cryaquepts

JAEH. Other Cryaquepts which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.
Vertic Cryaquepts

JAEI. Other Cryaquepts that have a histic epipedon.
Histic Cryaquepts

JAEJ. Other Cryaquepts which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
Aquandic Cryaquepts

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Halaquepts

JACC. Other Halaquepts that have a chroma of 3 or more in 40 percent or more of the matrix of one or more horizons between 15 and 75 cm from the mineral soil surface.

Aeric Halaquepts

JACD. Other Halaquepts that have a mollic epipedon.

Mollic Halaquepts

JACE. Other Halaquepts.

Typic Halaquepts

Humaquepts

Key to subgroups

JAIA. Humaquepts that have an *n* value *either* of 0.7 in one or more layers between 20 and 50 cm from the mineral soil surface, *or* of 0.9 or more in one or more layers between 50 and 80 cm.

Hydraquentic Humaquepts

JAIB. Other Humaquepts which have a histic epipedon.

Histic Humaquepts

JAIC. Other Humaquepts which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Placaquepts

JABC. Other Placaquepts that do not, within 100 cm of the mineral soil surface, have a continuous placic horizon in each pedon.

Haplic Placaquepts

JABD. Other Placaquepts.

Typic Placaquepts

Plinthaquepts

Key to subgroups

JAFA. All Plinthaquepts (provisionally).

Typic Plinthaquepts

Sulfaquepts

Key to subgroups

JAAA. Sulfaquepts that have a salic horizon within 75 cm of the mineral soil surface.

Salidic Sulfaquepts

JAAB. Other Sulfaquepts that have *both*:

1. An *n* value of more than 0.7; *and*

2. Eight percent or more clay in the fine-earth fraction of all horizons between 20 and 50 cm from the mineral soil surface.

Hydraquentic Sulfaquepts

JAAC. Other Sulfaquepts.

Typic Sulfaquepts

Tropaquepts

Key to subgroups

JAGA. Tropaquepts which have, within 150 cm of the mineral soil surface, *one or more* of the following:

1. A sulfuric horizon; *or*

2. A horizon 15 cm or more thick that has all the characteristics of a sulfuric horizon, except that it has a pH between 3.5 and 4.0; *or*

3. Sulfidic materials.

Sulfic Tropaquepts

JAGB. Other Tropaquepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Tropaquepts

JAGC. Other Tropaquepts which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Tropaquepts

JAGD. Other Tropaquepts that have a histic epipedon.

Histic Tropaquepts

JAGE. Other Tropaquepts which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Tropaquepts

JAGF. Other Tropaquepts that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Tropaquepts

JAGG. Other Tropaquepts that have, in 50 percent or more of the matrix of one or more horizons between either the Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, colors as follows:

1. A hue of 2.5Y or redder, a color value, moist, of 6 or more, and a chroma of 3 or more; *or*

2. A hue of 2.5Y or redder, a color value, moist, of 5 or less, and a chroma of 2 or more; *or*

3. A hue of 5Y and a chroma of 3 or more; *or*

4. A chroma of 2 or more if there are no redox concentrations.

Aeric Tropaquepts

JAGH. Other Tropaquepts.

Typic Tropaquepts

Vermaquepts

Key to subgroups

JAHA. Vermaquepts that have an exchangeable sodium percentage of 7 or more (or a sodium adsorption ratio, SAR, of 6 or more) in one or more subhorizons within 100 cm of the mineral soil surface.

Sodic Vermaquepts

JAHB. Other Vermaquepts.

Typic Vermaquepts

Ochrepts

Key to great groups

JDA. Ochrepts that have a sulfuric horizon within 50 cm of the mineral soil surface.

Sulfochrepts, p. 350

JDB. Other Ochrepts that have a fragipan.

Fragiochrepts, p. 349

JDC. Other Ochrepts which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Durochrepts, p. 340

JDD. Other Ochrepts that have a cryic or pergelic soil temperature regime.

Cryochrepts, p. 339

JDE. Other Ochrepts that have an ustic moisture regime.

Ustochrepts, p. 350

JDF. Other Ochrepts that have a xeric moisture regime.

Xerochrepts, p. 357

JDG. Other Ochrepts that have *one or both* of the following:

1. Carbonates within the soil; *or*

2. Base saturation (by NH_4OAc) of 60 percent or more in one or more horizons between 25 and 75 cm from the mineral soil surface.

Eutrochrepts, p.346

JDH. Other Ochrepts.

Dystrochrepts, p. 342

Cryochrepts

Key to subgroups

JDDA. Cryochrepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryochrepts

JDDB. Other Cryochrepts that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryochrepts

JDDC. Other Cryochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Cryochrepts

JDDD. Other Cryochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Cryochrepts

JDDE. Other Cryochrepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Cryochrepts

JDDF. Other Cryochrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Cryochrepts

JDDG. Other Cryochrepts which have a cambic horizon composed of lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Cryochrepts

JDDH. Other Cryochrepts that have a base saturation (by NH_4OAc) of less than 60 percent in all horizons within 75 cm of the mineral soil surface.

Dystric Cryochrepts

JDDI. Other Cryochrepts.

Typic Cryochrepts

Durochrepts

Key to subgroups

JDCA. Durochrepts which have *both*:

1. In one or more horizons within 30 cm of the mineral soil surface, distinct or prominent redox concentrations, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

    a. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

    b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

c. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

  (1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

  (2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Durochrepts

JDCB. Other Durochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Durochrepts

JDCC. Other Durochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Durochrepts

JDCD. Other Durochrepts that have, in one or more horizons within 30 cm of the mineral soil surface, distinct or prominent redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Durochrepts

JDCE. Other Durochrepts that do not have a xeric moisture regime.

Ustic Durochrepts

JDCF. Other Durochrepts which have *both*:

1. A duripan that is not indurated in any subhorizon; *and*

2. A base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.
Dystric Entic Durochrepts

JDCG. Other Durochrepts which have a duripan that is not indurated in any subhorizon.
Entic Durochrepts

JDCH. Other Durochrepts that have a base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.
Dystric Durochrepts

JDCI. Other Durochrepts.
Typic Durochrepts

Dystrochrepts

Key to subgroups

JDHA. Dystrochrepts that have:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon in less than half of each pedon; *and*

3. A base saturation (by sum of cations) of 35 percent or more in the horizon directly above the lithic contact.
Lithic Ruptic-Alfic Dystrochrepts

JDHB. Other Dystrochrepts that have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon in less than half of each pedon.
Lithic Ruptic-Ultic Dystrochrepts

JDHC. Other Dystrochrepts that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Dystrochrepts

JDHD. Other Dystrochrepts which have *both*:

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

a. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

c. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

(1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

(2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Dystrochrepts

JDHE. Other Dystrochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Dystrochrepts

JDHF. Other Dystrochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Dystrochrepts

JDHG. Other Dystrochrepts that have *both*:

1. Fragic soil properties;

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions in most years (or artificial drainage).

Fragiaquic Dystrochrepts

JDHH. Other Dystrochrepts which have:

1. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Fluvaquentic Dystrochrepts

JDHI. Other Dystrochrepts that have, in one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Dystrochrepts

JDHJ. Other Dystrochrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Dystrochrepts

JDHK. Other Dystrochrepts that have fragic soil properties;

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Dystrochrepts

JDHL. Other Dystrochrepts which have a cambic horizon composed of lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Dystrochrepts

JDHM. Other Dystrochrepts which have:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less than 25 percent; *and*

3. An Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Fluventic Umbric Dystrochrepts

JDHN. Other Dystrochrepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Dystrochrepts

JDHO. Other Dystrochrepts that have an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample), or materials between the soil surface and a depth of 18 cm which have these color values after mixing.

Umbric Dystrochrepts

JDHP. Other Dystrochrepts that have *both*:

1. An argillic horizon in less than half of each pedon; *and*

2. A base saturation (by sum of cations) of 35 percent or more either at a depth of 125 cm from the top of the argillic horizon, or directly above a densic, lithic, or paralithic contact if shallower.

Ruptic-Alfic Dystrochrepts

JDHQ. Other Dystrochrepts that have an argillic horizon in less than half of each pedon.

Ruptic-Ultic Dystrochrepts

120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udifluventic Ustochrepts

JDEM. Other Ustochrepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Ustochrepts

JDEN. Other Ustochrepts that have a gypsic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Gypsic Ustochrepts

JDEO. Other Ustochrepts which have *both*:

1. A calcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. When neither irrigated nor fallowed to store moisture, *one* of the following:

   a. A frigid soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in all parts for four tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   c. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Haplocalcidic Ustochrepts

JDEP. Other Ustochrepts which have *both*:

1. A calcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

(1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

(2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Xerochrepts

JDFH. Other Xerochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Xerochrepts

JDFI. Other Xerochrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Xerochrepts

JDFJ. Other Xerochrepts that have *both*:

1. Fragic soil properties:

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions in most years (or artificial drainage).

Fragiaquic Xerochrepts

JDFK. Other Xerochrepts that have a gypsic horizon within 100 cm of the mineral soil surface.

Gypsic Xerochrepts

JDFL. Other Xerochrepts that have *both:*

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.

Aquic Dystric Xerochrepts

JDFM. Other Xerochrepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Xerochrepts

JDFN. Other Xerochrepts which have a cambic horizon composed of lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Xerochrepts

JDFO. Other Xerochrepts that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Xerochrepts

JDFP. Other Xerochrepts which have:

1. A base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface; *and*

2. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Dystric Fluventic Xerochrepts

JDFQ. Other Xerochrepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.
Fluventic Xerochrepts

JDFR. Other Xerochrepts that have a base saturation (by NH_4OAc) of less than 60 percent in all horizons between 25 and 75 cm from the mineral soil surface.
Dystric Xerochrepts

JDFS. Other Xerochrepts that have a calcic horizon or identifiable secondary carbonates within one of the following particle-size class and depth combinations:

1. A sandy or sandy-skeletal particle-size class and within 150 cm of the mineral soil surface; *or*

2. A clayey, clayey-skeletal, fine, or very-fine particle - size class and within 90 cm of the mineral soil surface; *or*

3. Any other particle-size class and within 110 cm of the mineral soil surface.
Calcixerollic Xerochrepts

JDFT. Other Xerochrepts.
Typic Xerochrepts

Plaggepts

INC

Key to subgroups

JBA. All Plaggepts (provisionally).
Typic Plaggepts

Tropepts

Key to great groups

JCA. Tropepts which:

1. Have a base saturation of less than 50 percent (by NH_4OAc) in one or more horizons between 25 and 100 cm from the mineral soil surface; *and*

2. Have 12 kg/m^2 or more organic carbon between the mineral soil surface and either a depth of 100 cm or a densic, lithic, paralithic, or petroferric contact, whichever is shallower; *and*

3. Do not have a sombric horizon.
Humitropepts, p. 366

less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Dystropepts

JCEE. Other Dystropepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

    a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

    b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Dystropepts

JCEF. Other Dystropepts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Dystropepts

JCEG. Other Dystropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Dystropepts

JCEH. Other Dystropepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Dystropepts

JCEI. Other Dystropepts that have *both*:

1. An ustic moisture regime; *and*

2. A CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[1] in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a densic, lithic, or paralithic contact if shallower.

Ustoxic Dystropepts

JCEJ. Other Dystropepts that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[2] in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a densic, lithic, or paralithic contact if shallower.

Oxic Dystropepts

JCEK. Other Dystropepts that have an ustic moisture regime.

Ustic Dystropepts

JCEL. Other Dystropepts.

Typic Dystropepts

Eutropepts

Key to subgroups

JCDA. Eutropepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Eutropepts

JCDB. Other Eutropepts which have *both:*

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a

---

[1] Some cambic horizons with properties that approach those of an oxic horizon do not disperse well. If the ratio of (percent water retained at 1500 kPa tension minus percent organic carbon) to the percentage of measured clay in the fine-earth fraction is 0.6 or more, then the percentage of clay is considered to equal either (1) the measured percentage of clay, or (2) three times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

[2] See footnote 1.

chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquertic Eutropepts

JCDC. Other Eutropepts which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Eutropepts

JCDD. Other Eutropepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Eutropepts

JCDE. Other Eutropepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one* or *both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Eutropepts

JCDF. Other Eutropepts that have:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.
Fluvaquentic Eutropepts

JCDG. Other Eutropepts that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Eutropepts

JCDH. Other Eutropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
Oxyaquic Eutropepts

JCDI. Other Eutropepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.
Fluventic Eutropepts

JCDJ. Other Eutropepts.
Typic Eutropepts

Humitropepts

Key to subgroups

JCAA. Humitropepts that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Humitropepts

JCAB. Other Humitropepts which have *both*:

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquertic Humitropepts

JCAC. Other Humitropepts which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Humitropepts

JCAD. Other Humitropepts that have *both*:

1. An ustic moisture regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Ustandic Humitropepts

JCAE. Other Humitropepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Humitropepts

JCAF. Other Humitropepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66

JCAK. Other Humitropepts that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[4] in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a densic, lithic, or paralithic contact if shallower.

Oxic Humitropepts

JCAL. Other Humitropepts that have an ustic moisture regime.

Ustic Humitropepts

JCAM. Other Humitropepts.

Typic Humitropepts

Sombritropepts

Key to subgroups

JCBA. All Sombritropepts (provisionally).

Typic Sombritropepts

Ustropepts

Key to subgroups

JCCA. Ustropepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Ustropepts

JCCB. Other Ustropepts which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Ustropepts

JCCC. Other Ustropepts that have, in one or more horizons within 100 cm of the mineral soil surface,

[4] See footnote 3.

redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Ustropepts

JCCD. Other Ustropepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Ustropepts

JCCE. Other Ustropepts that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[5] in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a densic, lithic, or paralithic contact if shallower.

Oxic Ustropepts

JCCF. Other Ustropepts which have *both*:

1. *Either* 0.2 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Ustropepts

JCCG. Other Ustropepts.

Typic Ustropepts

Umbrepts

Key to great groups

JEA. Umbrepts that have a fragipan.

Fragiumbrepts, p. 372

JEB. Other Umbrepts that have a cryic or pergelic soil temperature regime.

Cryumbrepts, p. 371

JEC. Other Umbrepts that have a xeric moisture regime.

Xerumbrepts, p. 375

JED. Other Umbrepts.

Haplumbrepts, p. 373

[5] See footnote 3.

JEBG. Other Cryumbrepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Cryumbrepts

JEBH. Other Cryumbrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Cryumbrepts

JEBI. Other Cryumbrepts that do not have a cambic horizon.

Entic Cryumbrepts

JEBJ. Other Cryumbrepts.

Typic Cryumbrepts

Fragiumbrepts

Key to subgroups

JEAA. Fragiumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Fragiumbrepts

JEAB. Other Fragiumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

    a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

    b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Fragiumbrepts

JEAC. Other Fragiumbrepts that have, in one or more horizons within 50 cm of the mineral soil surface,

less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haplumbrepts

JEDD. Other Haplumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

    a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

    b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haplumbrepts

JEDE. Other Haplumbrepts that have, in one or more horizons within 50 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haplumbrepts

JEDF. Other Haplumbrepts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haplumbrepts

JEDG. Other Haplumbrepts which have a cambic horizon composed of lamellae (two or more) within 200 cm of the mineral soil surface.

Psammentic Haplumbrepts

JEDH. Other Haplumbrepts which have:

1. An umbric or a mollic epipedon that is 50 cm or more thick; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Cumulic Haplumbrepts

JEDI. Other Haplumbrepts that have an umbric or a mollic epipedon that is 50 cm or more thick.

Pachic Haplumbrepts

JEDJ. Other Haplumbrepts which have *both*:

1. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less 25 percent.

Fluventic Haplumbrepts

JEDK. Other Haplumbrepts that do not have a cambic horizon.

Entic Haplumbrepts

JEDL. Other Haplumbrepts.

Typic Haplumbrepts

Xerumbrepts

Key to subgroups

JECA. Xerumbrepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Xerumbrepts

JECB. Other Xerumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Xerumbrepts

JECC. Other Xerumbrepts that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Xerumbrepts

JECD. Other Xerumbrepts that have an umbric or a mollic epipedon that is 50 cm or more thick.

Pachic Xerumbrepts

JECE. Other Xerumbrepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Xerumbrepts

JECF. Other Xerumbrepts which have *both*:

1. An irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Xerumbrepts

JECG. Other Xerumbrepts that do not have a cambic horizon.

Entic Xerumbrepts

JECH. Other Xerumbrepts.

Typic Xerumbrepts

CHAPTER 11

MOLLISOLS

Key to suborders

HA. Mollisols that have:

1. An argillic or a natric horizon; *and*

2. An albic horizon with a chroma of 2 or less that is 2.5 cm or more thick, has its lower boundary 18 cm or more below the mineral soil surface, and either lies directly below the mollic epipedon or separates horizons that together meet all the requirements for a mollic epipedon; *and*

3. In one or more subhorizons of the albic and/or the argillic or natric horizon and within 100 cm of the mineral soil surface, redox concentrations in the form of masses or concretions or both, and also aquic conditions for some time in most years (or artificial drainage).

Albolls, p. 379

HB. Other Mollisols that have in a layer above a densic, lithic, or paralithic contact or in a layer between 40 and 50 cm from the mineral soil surface, whichever is shallower, aquic conditions for some time in most years (or artificial drainage) *and one or more* of the following:

1. A histic epipedon overlying the mollic epipedon; *or*

2. An exchangeable sodium percentage (ESP) of 15 or more (or a sodium adsorption ratio, SAR, of 13 or more) in the upper part of the mollic epipedon, and a decrease in ESP (or SAR) values with increasing depth below 50 cm from the mineral soil surface; *or*

3. A calcic or petrocalcic horizon that has its upper boundary within 40 cm of the mineral soil surface; *or*

4. *One* of the following colors:

    a. A chroma of 1 or less in the lower part of the mollic epipedon[1], *and either*

        (1) Distinct or prominent redox concentrations in the lower part of the mollic epipedon; *or*

---

[1] If the mollic epipedon extends to a lithic contact within 30 cm of the mineral soil surface, the requirement for redoximorphic features is waived.

(2) Either directly below the mollic epipedon, or within 75 cm of the mineral soil surface if a calcic horizon intervenes, a color value, moist, of 4 or more *and one* of the following:

(a) Fifty percent or more chroma of 1 on aces of peds or in the matrix, a hue of 10YR or redder, and redox concentrations; *or*

(b) Fifty percent or more chroma of 2 or less on faces of peds or in the matrix, a hue of 2.5Y or yellower, and redox concentrations; *or*

(c) Fifty percent or more chroma of 1 on faces of peds or in the matrix, and a hue of 2.5Y or yellower; *or*

(d) Fifty percent or more chroma of 3 or less on faces of peds or in the matrix, a hue of 5Y, and redox concentrations; *or*

(e) Fifty percent or more chroma of 0 on faces of peds or in the matrix; *or*

(f) A hue of 5GY, 5G, 5BG, or 5B; *or*

(g) Any color if it results from uncoated sand grains; *or*

b. A chroma of 2 in the lower part of the mollic epipedon, *and either*

(1) Distinct or prominent redox concentrations in the lower part of the mollic epipedon; *or*

(2) Directly below the mollic epipedon, *one* of the following matrix colors:

(a) A color value, moist, of 4, a chroma of 2, and some redox depletions with a color value, moist, of 4 or more and a chroma of 1 or less; *or*

(b) A color value, moist, of 5 or more, a chroma of 2 or less, and redox concentrations; *or*

(c) A color value, moist, of 4 and a chroma of 1 or less; *or*

5. Between 40 and 50 cm from the mineral soil surface, enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquolls, p. 381

HC. Other Mollisols which:

1. Have a mollic epipedon less than 50 cm thick; *and*

2. Do not have an argillic or a calcic horizon; *and*

3. Have, either within or directly below the mollic epipedon, mineral soil materials less than 7.5 cm in diameter that have a $CaCO_3$ equivalent of 40 percent or more; *and*

4. Have either a udic moisture regime or a cryic soil temperature regime.

Rendolls, p. 415

HD. Other Mollisols that have either a xeric moisture regime or an aridic moisture regime bordering on a xeric regime, but do not have a cryic soil temperature regime.

Xerolls, p.450

HE. Other Mollisols that have a frigid, cryic, or pergelic soil temperature regime.

Borolls, p. 390

HF. Other Mollisols that have either an ustic moisture regime, or an aridic moisture regime that borders on an ustic regime.

Ustolls, **p. 426**

HG. Other Mollisols.

Udolls, **p.416**

Albolls

Key to great groups

HAA. Albolls that have a natric horizon.

Natralbolls, p. 381

HAB. Other Albolls.

Argialbolls, p. 379

Argialbolls

Key to subgroups

HABA. Argialbolls which have *both*:

HABF. Other Argialbolls which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Argialbolls

HABG. Other Argialbolls.

Typic Argialbolls

Natralbolls

Key to subgroups

HAAA. All Natralbolls (provisionally).

Typic Natralbolls

Aquolls

Key to great groups

HBA. Aquolls that have a cryic or pergelic soil temperature regime.

Cryaquolls, p. 383

HBB. Other Aquolls which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Duraquolls, p. 384

HBC. Other Aquolls that have a natric horizon.

Natraquolls, p. 389

HBD. Other Aquolls which have a calcic or gypsic horizon that has its upper boundary within 40 cm of the mineral soil surface, but do not have an argillic horizon unless it is a buried horizon.

Calciaquolls, p. 382

HBE. Other Aquolls that have an argillic horizon.
Argiaquolls, p. 382

HBF. Other Aquolls that have episaturation.
Epiaquolls, p. 387

HBG. Other Aquolls.
Endoaquolls, p. 385

Argiaquolls

Key to subgroups

HBEA. Argiaquolls that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm to 100 cm.
Arenic Argiaquolls

HBEB. Other Argiaquolls that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.
Grossarenic Argiaquolls

HBEC. Other Argiaquolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argiaquolls

HBED. Other Argiaquolls which have an argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.
Abruptic Argiaquolls

HBEE. Other Argiaquolls.
Typic Argiaquolls

Calciaquolls

Key to subgroups

HBDA. Calciaquolls which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.
Petrocalcic Calciaquolls

HBDB. Other Calciaquolls that have 50 percent or more chroma of 3 or more on faces of peds or in the matrix of one or more horizons within 75 cm of the mineral soil surface, or have, directly below the mollic epipedon, colors as follows:

1. A hue of 2.5Y or yellower and a chroma of 3 or more; *or*

2. A hue of 10YR or redder and a chroma of 2 or more; *or*

3. A hue of 2.5Y or yellower and a chroma of 2 or more if there are no distinct or prominent redox concentrations.

Aeric Calciaquolls

HBDC. Other Calciaquolls.

Typic Calciaquolls

Cryaquolls

Key to subgroups

HBAA. Cryaquolls that have a mean annual soil temperature of 0°C or lower.

Pergelic Cryaquolls

HBAB. Other Cryaquolls which have *one* or *both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Cryaquolls

HBAC. Other Cryaquolls that have a histic epipedon.

Histic Cryaquolls

HBAD. Other Cryaquolls which have a buried Histosol that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Cryaquolls

HBAE. Other Cryaquolls which have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

    a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

    b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
Aquandic Cryaquolls

HBAF. Other Cryaquolls that have an argillic horizon.
Argic Cryaquolls

HBAG. Other Cryaquolls that have a calcic horizon either within or directly below the mollic epipedon.
Calcic Cryaquolls

HBAH. Other Cryaquolls that have a mollic epipedon 50 cm or more thick.
Cumulic Cryaquolls

HBAI. Other Cryaquolls.
Typic Cryaquolls

Duraquolls

Key to subgroups

HBBA. Duraquolls that have a natric horizon.
Natric Duraquolls

HBBB. Other Duraquolls which have, above the duripan, *one or both* of the following:

1. Cracks that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick; *or*

2. A linear extensibility of 6.0 cm or more.
Vertic Duraquolls

HBBC. Other Duraquolls that have an argillic horizon.
Argic Duraquolls

aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Fluvaquentic Vertic Epiaquolls

HBFC. Other Epiaquolls that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Epiaquolls

HBFD. Other Epiaquolls that have a histic epipedon.

Histic Epiaquolls

HBFE. Other Epiaquolls which have a buried Histosol that has its upper boundary within 100 cm of the mineral soil surface.

Thapto-Histic Epiaquolls

HBFF. Other Epiaquolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or more* of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

HBCB. Other Natraquolls (provisionally).
Typic Natraquolls

Borolls

Key to great groups

HEA. Borolls which have *both*:

1. An argillic horizon that has its upper boundary 60 cm or more below the mineral soil surface; *and*

2. A texture finer than loamy fine sand in all horizons above the argillic horizon.
Paleborolls, p. 413

HEB. Other Borolls that have a cryic or pergelic soil temperature regime.
Cryoborolls, p. 398

HEC. Other Borolls which have a natric horizon, but do not have a cambic horizon that is above the natric horizon and separated from it by an albic horizon.
Natriborolls, p. 410

HED. Other Borolls which have an argillic horizon, but do not have a cambic horizon that is above the argillic horizon and separated from it by an albic horizon.
Argiborolls, p. 391

HEE. Other Borolls that have a mollic epipedon which:

1. Either below an Ap horizon or below a depth of 18 cm from the mineral soil surface, contains 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows; *and*

2. Either rests on a lithic contact, or has a transition zone to the underlying horizon in which 25 percent or more of the soil volume consists of discrete wormholes, worm casts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.
Vermiborolls, p. 414

HEF. Other Borolls which:

1. Have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. In all parts above the calcic or petrocalcic horizon, after the materials between the soil surface and a

2. *Both* of the following:

   a. A color value, dry, of 5 in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

   b. If not irrigated, a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher.

Torrertic Argiborolls

HEDD. Other Argiborolls that have:

1. A mollic epipedon 40 cm or more thick, of which 50 percent or more of the thickness has a texture finer than loamy fine sand; *and*

2. A udic moisture regime; *and*

3. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Pachic Udertic Argiborolls

HEDE. Other Argiborolls that have *both*:

1. A mollic epipedon 40 cm or more thick, of which 50 percent or more of the thickness has a texture finer than loamy fine sand; *and*

2. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

HEDH. Other Argiborolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argiborolls

HEDI. Other Argiborolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argiborolls

HEDJ. Other Argiborolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Argiborolls

HEDK. Other Argiborolls that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more below the mineral soil surface.

Arenic Argiborolls

HEDL. Other Argiborolls which have:

1. An argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm; *and*

2. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

3. A moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C.

Paleargidic Argiborolls

HEDM. Other Argiborolls which have *both*:

1. An argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm; *and*

2. udic moisture regime.

Abruptic Udic Argiborolls

HEDN. Other Argiborolls which have an argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

Abruptic Argiborolls

HEDO. Other Argiborolls which have *both*:

1. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*

2. A udic moisture regime.

Pachic Udic Argiborolls

HEDP. Other Argiborolls that have a mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand.

Pachic Argiborolls

HEDQ. Other Argiborolls which have *both*:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C.

Aridic Argiborolls

HEDR. Other Argiborolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Argiborolls

HEDS. Other Argiborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Argiborolls

HEDT. Other Argiborolls which have *both*:

1. A udic moisture regime; *and*

2. *Either*:

   a. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

   b. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Boralfic Udic Argiborolls

HEDU. Other Argiborolls which have *either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Boralfic Argiborolls

HEDV. Other Argiborolls that have a udic moisture regime.

Udic Argiborolls

HEDW. Other Argiborolls that have an albic horizon directly below the mollic epipedon.

Albollic Argiborolls

HEDX. Other Argiborolls.

Typic Argiborolls

Calciborolls

Key to subgroups

HEFA. Calciborolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calciborolls

HEFB. Other Calciborolls which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calciborolls

HEFC. Other Calciborolls which have *both*:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C.

Aridic Calciborolls

HEFD. Other Calciborolls that have, in one or more horizons within 100 cm of the mineral soil surface both:

1. Redoximorphic features; *and*

2. Aquic conditions for some time in most years (or artificial drainage).

Aquic Calciborolls

HEFE. Other Calciborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Calciborolls

HEFF. Other Calciborolls that have a udic moisture regime.

Udic Calciborolls

HEFG. Other Calciborolls.

Typic Calciborolls

Cryoborolls

Key to subgroups

HEBA. Cryoborolls which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon, *and either*:

   a. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

   b. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Boralfic Lithic Cryoborolls

HEBB. Other Cryoborolls which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon that is discontinuous in each pedon.

Lithic Ruptic-Argic Cryoborolls

HEBC. Other Cryoborolls which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. An argillic horizon.

Argic Lithic Cryoborolls

HEBD. Other Cryoborolls which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. A mollic epipedon that is discontinuous in each pedon.

Lithic Ruptic-Entic Cryoborolls

HEBE. Other Cryoborolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryoborolls

HEBF. Other Cryoborolls that have a mean annual soil temperature of 0°C or less.

Pergelic Cryoborolls

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Cryoborolls

HEBL. Other Cryoborolls which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Duric Cryoborolls

HEBM. Other Cryoborolls which have *both*:

1. An albic horizon directly below the mollic epipedon; *and*

2. An argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) at its upper boundary or within the upper 7.5 cm.

Abruptic Cryoborolls

HEBN. Other Cryoborolls which have an argillic horizon, *and either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Boralfic Cryoborolls

HEBO. Other Cryoborolls which have:

1. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent; *and*

4. In one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Cumulic Cryoborolls

HEBP. Other Cryoborolls which have:

1. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.
Cumulic Cryoborolls

HEBQ. Other Cryoborolls which have *both*:

1. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand; *and*

2. A calcic horizon either within or directly below the mollic epipedon, but *no* argillic horizon in the lower part of the mollic epipedon.
Calcic Pachic Cryoborolls

HEBR. Other Cryoborolls that have *both*:

1. An argillic horizon; *and*

2. A mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand.
Argic Pachic Cryoborolls

HEBS. Other Cryoborolls that have a mollic epipedon 40 cm or more thick with a texture finer than loamy fine sand.
Pachic Cryoborolls

HEBT. Other Cryoborolls that have *both*:

1. An argillic horizon; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, distinct or prominent redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).
Argiaquic Cryoborolls

Haploborolls

Key to subgroups

HEGA. Haploborolls which have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

Salidic Haploborolls

HEGB. Other Haploborolls that have, in part but not all of each pedon, a lithic contact within 50 cm of the mineral soil surface.

Ruptic-Lithic Haploborolls

HEGC. Other Haploborolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploborolls

HEGD. Other Haploborolls that have *both*:

1. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. *One or both* of the following:

    a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

    b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Aquertic Haploborolls

HEGE. Other Haploborolls that have:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle- size class, and the soil has no densic or paralithic contact nor any sandy or sandy-skeletal particle-size class between 40 and 50 cm from the mineral soil surface; *and*

2. An irregular decrease in organic carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent and a concave shape; *and*

4. A udic moisture regime; *and*

5. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Cumulic Udertic Haploborolls

HEGF. Other Haploborolls which have:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle- size class, and the soil has no densic or paralithic contact nor any sandy or sandy-skeletal particle-size class between 40 and 50 cm from the mineral soil surface; *and*

2. An irregular decrease in organic carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent and a concave shape; *and*

4. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

HEGI. Other Haploborolls which have *both:*

1. A udic moisture regime; *and*

2. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Udertic Haploborolls

HEGJ. Other Haploborolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haploborolls

HEGK. Other Haploborolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haploborolls

HEGL. Other Haploborolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haploborolls

HEGM. Other Haploborolls which have:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle- size class, and the soil has no densic or paralithic contact nor any sandy or sandy-skeletal particle-size class between 40 and 50 cm from the mineral soil surface; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent; *and*

4. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Cumulic Haploborolls

HEGN. Other Haploborolls which have:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle size class, and the soil has no densic or paralithic contact nor any sandy or sandy-skeletal particle-size class between 40 and 50 cm from the mineral soil surface; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent and a concave shape; *and*

4. A udic moisture regime.

Cumulic Udic Haploborolls

HEGO. Other Haploborolls which have:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle size class, and the soil has no densic or paralithic contact nor any sandy or sandy-skeletal particle-size class between 40 and 50 cm from the mineral soil surface; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent and a concave shape.

Cumulic Haploborolls

HEGP. Other Haploborolls that have *both*:

1. A mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle size class, and the soil has no densic or paralithic contact nor any sandy or sandy-skeletal particle-size class between 40 and 50 cm from the mineral soil surface; *and*

2. A udic moisture regime.

Pachic Udic Haploborolls

HEGQ. Other Haploborolls that have a mollic epipedon 40 cm or more thick, of which less than 50 percent has a sandy or sandy-skeletal particle-size class, and the soil has no densic or paralithic contact nor any sandy or sandy-skeletal particle-size class between 40 and 50 cm from the mineral soil surface.

Pachic Haploborolls

HEGR. Other Haploborolls that have:

1. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

3. A slope of less than 25 percent.

Fluvaquentic Haploborolls

HEGS. Other Haploborolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haploborolls

HEGT. Other Haploborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haploborolls

HEGU. Other Haploborolls which have:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. If not irrigated, a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is 5°C or higher; *and*

3. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

4. A slope of less than 25 percent.

Torrifluventic Haploborolls

HEGV. Other Haploborolls which:

1. Have a color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. If not irrigated, have a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm from the soil surface is 5°C or higher; *and*

3. Do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color.

Torriorthentic Haploborolls

HEGW. Other Haploborolls which have *both*:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C.

Aridic Haploborolls

HEGX. Other Haploborolls which have *both*:

1. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a lithic or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Haploborolls

HEGY. Other Haploborolls which:

1. Have a udic moisture regime; *and*

2. Do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color.

Udorthentic Haploborolls

HEGZ. Other Haploborolls that have a udic moisture regime.

Udic Haploborolls

HEGZa. Other Haploborolls that do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color.

Entic Haploborolls

HEGZb. Other Haploborolls.

Typic Haploborolls

Natriborolls

Key to subgroups

HECA. Natriborolls that have both:

1. Visible crystals of gypsum and/or more soluble salts within 40 cm of the mineral soil surface; *and*

2. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Leptic Vertic Natriborolls

HECB. Other Natriborolls that have:

1. A color value, dry, of 5 or more either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *and*

3. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Torrertic Natriborolls

HECC. Other Natriborolls which have *both*:

1. A udic moisture regime; *and*

2. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Udertic Natriborolls

HEAF. Other Paleborolls that have a mollic epipedon 50 cm or more thick.

Pachic Paleborolls

HEAG. Other Paleborolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Paleborolls

HEAH. Other Paleborolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Paleborolls

HEAI. Other Paleborolls.

Typic Paleborolls

Vermiborolls

Key to subgroups

HEEA. Vermiborolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Vermiborolls

HEEB. Other Vermiborolls which have *both*:

1. A color value, dry, of 5 either in the upper 18 cm of the mollic epipedon, after mixing, or in an Ap horizon 18 cm or more thick; *and*

2. A moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C.

Aridic Vermiborolls

HEEC. Other Vermiborolls that have both:

1. A mollic epipedon less than 75 cm thick; *and*

2. A udic soil moisture regime.

Hapludic Vermiborolls

HEED. Other Vermiborolls that have a udic soil moisture regime.

Udic Vermiborolls

HEEE. Other Vermiborolls that have a mollic epipedon less than 75 cm thick.

Haplic Vermiborolls

HCAH. Other Rendolls.

Typic Rendolls

Udolls

Key to great groups

HGA. Udolls which have *either*:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*

2. *Both*:

   a. Within 150 cm of the mineral soil surface, neither a densic, lithic, or paralithic contact nor a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *and*

   b. An argillic horizon which has *either*:

      (1) In its lowest subhorizon, a hue of 7.5YR or redder and a chroma of 5 or more in 50 percent or more of the matrix; *or*

      (2) In one or more of its subhorizons, many coarse redox concentrations with a hue of 5YR or redder or a chroma of 6 or more, or both.

Paleudolls, p. 425

HGB. Other Udolls which:

1. Have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. Do *not* have an argillic horizon above the calcic horizon; *and*

3. In all parts above the calcic or petrocalcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, are either calcareous or have a texture of loamy fine sand or coarser.

Calciudolls, p. 420

HGC. Other Udolls that have an argillic horizon.

Argiudolls, p. 417

HGD. Other Udolls that have a mollic epipedon which:

1. Either below an Ap horizon or below a depth of 18 cm from the mineral soil surface, contains 50

percent or more (by volume) wormholes, worm casts, or filled animal burrows; *and*

2. Either rests on a lithic contact, or has a transition zone to the underlying horizon in which 25 percent or more of the soil volume consists of discrete wormholes, worm casts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.

Vermudolls, p. 426

HGE. Other Udolls.

Hapludolls, p. 421

Argiudolls

Key to subgroups

HGCA. Argiudolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Argiudolls

HGCB. Other Argiudolls which have *both*:

1. Aquic conditions for some time in most years (or artificial drainage), *either*:

   a. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*

   b. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:

      (1) A color value, moist, of 4 or more and redox depletions with a chroma of 2 or less; *or*

      (2) A hue of 10YR or redder and a chroma of 2 or less; *or*

      (3) A hue of 2.5Y or yellower and a chroma of 3 or less; *and*

2. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Aquertic Argiudolls

HGCC. Other Argiudolls that have *both:*

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. Saturation with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Vertic Argiudolls

HGCD. Other Argiudolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argiudolls

HGCE. Other Argiudolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argiudolls

HGCF. Other Argiudolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

    a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

    b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Argiudolls

HGCG. Other Argiudolls which have aquic conditions for some time in most years (or artificial drainage), *either*:

1. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*

2. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:

    a. A color value, moist, of 4 or more and redox depletions with a chroma of 2 or less; *or*

    b. A hue of 10YR or redder and a chroma of 2 or less; *or*

    c. A hue of 2.5Y or yellower and a chroma of 3 or less.

Aquic Argiudoll

HGCH. Other Argiudolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Argiudolls

HGCI. Other Argiudolls that have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons which are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there is either:

a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

b. A combination of lamellae (that may or may not be part of the argillic horizon), and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Argiudolls

HGCJ. Other Argiudolls that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Argiudolls

HGCK. Other Argiudolls which have an argillic horizon that has a clay increase with depth of 20 percent or more (absolute, in the fine-earth fraction) within its upper 7.5 cm.

Abruptic Argiudolls

HGCL. Other Argiudolls that have an albic horizon that is directly below the mollic epipedon or is a part of the (ochric) epipedon.

Albic Argiudolls

HGCM. Other Argiudolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Argiudolls

HGCN. Other Argiudolls that have a CEC of less than 24 cmol(+)/kg clay (by 1N NH_4OAc pH 7) in 50 percent or more *either* of the argillic horizon if less than 100 cm thick, *or* of its upper 100 cm.

Oxic Argiudolls

HGCO. Other Argiudolls that have a calcic horizon within 100 cm of the mineral soil surface.

Calcic Argiudolls

HGCP. Other Argiudolls.

Typic Argiudolls

Calciudolls

<u>Key to subgroups</u>

HGBA. Calciudolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calciudolls

HGBB. Other Calciudolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Calciudolls

HGBC. Other Calciudolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Calciudolls

HGBD. Other Calciudolls.

Typic Calciudolls

Hapludolls

Key to subgroups

HGEA. Hapludolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Hapludolls

HGEB. Other Hapludolls which have *both*:

1. Aquic conditions for some time in most years (or artificial drainage), *either*:

   a. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*

   b. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:

      (1) A color value, moist, of 4 or more and redox depletions with a chroma of 2 or less; *or*

      (2) A hue of 10YR or redder and a chroma of 2 or less; *or*

      (3) A hue of 2.5Y or yellower and a chroma of 3 or less; *and*

b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.
Vitrandic Hapludolls

HGEF. Other Hapludolls which have:

1. A mollic epipedon 60 cm or more thick, of which 50 percent or more of the thickness has a texture finer than loamy fine sand; *and*

2. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of 25 percent or less; *and*

4. In one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Cumulic Hapludolls

HGEG. Other Hapludolls which have:

1. A mollic epipedon 60 cm or more thick with a texture finer than loamy fine sand; *and*

2. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of 25 percent or less.
Cumulic Hapludolls

HGEH. Other Hapludolls that have:

1. Aquic conditions for some time in most years (or artificial drainage), *either*:

   a. Within 40 cm of the mineral soil surface, in horizons that also have redoximorphic features; *or*

   b. Directly below the mollic epipedon, in one or more horizons with a total thickness of 15 cm or more that have *one or more* of the following:

      (1) A color value, moist, of 4 or more and redox depletions with a chroma of 2 or less; *or*

HGEL. Other Hapludolls which have *both*:

1. A mollic epipedon 60 cm or more thick that has a texture finer than loamy fine sand and contains 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows, either below an Ap horizon or below a depth of 18 cm from the mineral soil surface; *and*

2. *Either* do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color, *or* have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.
Vermic Hapludolls

HGEM. Other Hapludolls that have a calcic horizon within 100 cm of the mineral soil surface.
Calcic Hapludolls

HGEN. Other Hapludolls that *either*:

1. Do not have a cambic horizon *and* do not, in any part of the mollic epipedon below 25 cm from the mineral soil surface, meet all the requirements for a cambic horizon except color; *or*

2. Have free carbonates throughout the cambic horizon *or* all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.
Entic Hapludolls

HGEO. Other Hapludolls.
Typic Hapludolls

Paleudolls

Key to subgroups

HGAA. Paleudolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.
Vertic Paleudolls

HGAB. Other Paleudolls that have a petrocalcic horizon within 150 cm of the mineral soil surface.
Petrocalcic Paleudolls

HGAC. Other Paleudolls that have, in one or more subhorizons within the upper 50 cm of the argillic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Paleudolls

HGAD. Other Paleudolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.
Oxyaquic Paleudolls

HGAE. Other Paleudolls which:

1. Have a calcic horizon that has its upper boundary within 100 cm of the mineral soil surface; *and*

2. In all parts above the calcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, are either calcareous or have a texture of loamy fine sand or coarser.
Calcic Paleudolls

HGAF. Other Paleudolls.
Typic Paleudolls

Vermudolls

Key to subgroups

HGDA. Vermudolls that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Vermudolls

HGDB. Other Vermudolls that have a cambic horizon.
Haplic Vermudolls

HGDC. Other Vermudolls that have a mollic epipedon less than 75 cm thick.
Entic Vermudolls

HGDD. Other Vermudolls.
Typic Vermudolls

Ustolls

Key to great groups

HFA. Ustolls which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.
Durustolls, p. 436

HFB. Other Ustolls that have a natric horizon.
Natrustolls, p. 444

HFC. Other Ustolls which have *either*:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface, *and* either an argillic horizon or, after the materials between the soil surface and a depth of 18 cm have been mixed, one or more noncalcareous horizons above the petrocalcic horizon; *or*

2. An argillic horizon that has *one or both* of the following:

   a. *No* clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content within 150 cm of the mineral soil surface (and there is no densic, lithic, or paralithic contact within that depth), *and either*:

      (1) A hue of 7.5YR or redder and a chroma of 5 or more in the matrix; *or*

      (2) Common coarse redox concentrations with a hue of 7.5YR or redder or a chroma of 6 or more, or both; *or*

   b. Thirty-five percent or more clay in its upper part, and at its upper boundary, a clay increase of either 20 percent or more (absolute) within a vertical distance of 7.5 cm, or of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction (and there is no densic, lithic, or paralithic contact within 50 cm of the mineral soil surface).
   Paleustolls, **p. 446**

HFD. Other Ustolls which:

1. Have *either* a calcic or gypsic horizon that has its upper boundary within 100 cm of the soil surface, *or* a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *and*

2. Do not have an argillic horizon above the calcic, gypsic, or petrocalcic horizon; *and*

3. In all parts above the calcic, gypsic, or petrocalcic horizon, after the materials between the soil surface and a depth of 18 cm have been mixed, are either calcareous or have a texture of loamy fine sand or coarser.
Calciustolls, p. 433

HFE. Other Ustolls that have an argillic horizon.
Argiustolls, p. 428

HFF. Other Ustolls that have a mollic epipedon which:

1. Either below an Ap horizon or below a depth of 18 cm from the mineral soil surface, contains 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows; *and*

2. Either rests on a lithic contact, or has a transition zone to the underlying horizon in which 25 percent or more of the soil volume consists of discrete wormholes, worm casts, or animal burrows filled with material from the mollic epipedon and from the underlying horizon.
Vermustolls, p. 449

HFG. Other Ustolls.
Haplustolls, p. 436

Argiustolls

Key to subgroups

HFEA. Argiustolls which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. Above the argillic horizon, either an albic horizon, or a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon.
Alfic Lithic Argiustolls

HFEB. Other Argiustolls that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Argiustolls

HFEC. Other Argiustolls that have *both*:

1. *One or both* of the following:

    a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

    b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. When neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Torrertic Argiustolls

HFED. Other Argiustolls which have *both*:

1. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. When neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udertic Argiustolls

HFEE. Other Argiustolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argiustolls

HFEF. Other Argiustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argiustolls

HFEG. Other Argiustolls which have *both*:

1. When neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

b. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

(1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

(2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitritorrandic Argiustolls

HFEH. Other Argiustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Argiustolls

HFEI. Other Argiustolls which have a mean annual soil temperature lower than 10°C, *and either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Boralfic Argiustolls

HFEJ. Other Argiustolls which have *either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Ustalfic Argiustolls

HFEK. Other Argiustolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Argiustolls

HFEL. Other Argiustolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Argiustolls

HFEM. Other Argiustolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Argiustolls

HFEN. Other Argiustolls which have, when neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Argiustolls

HFEO. Other Argiustolls which have, when neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some

slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Calciustolls

HFDG. Other Calciustolls which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calciustolls

HFDH. Other Calciustolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Calciustolls

HFDI. Other Calciustolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Calciustolls

HFDJ. Other Calciustolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Calciustolls

HFDK. Other Calciustolls which have, when neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Calciustolls

HFDL. Other Calciustolls which have, when neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for four tenths

or less consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Calciustolls

HFDM. Other Calciustolls.

Typic Calciustolls

Durustolls

Key to subgroups

HFAA. Durustolls that have a natric horizon above the duripan.

Natric Durustolls

HFAB. Other Durustolls which:

1. Do not have an argillic horizon above the duripan; *and*

2. Have an aridic moisture regime that borders on an ustic regime.

Haploduridic Durustolls

HFAC. Other Durustolls that have an aridic moisture regime that borders on an ustic regime.

Argiduridic Durustolls

HFAD. Other Durustolls that do not have an argillic horizon above the duripan.

Entic Durustolls

HFAE. Other Durustolls which have a duripan that is neither very strongly cemented *nor* indurated in any subhorizon.

Haplic Durustolls

HFAF. Other Durustolls.

Typic Durustolls

Haplustolls

Key to subgroups

HFGA. Haplustolls which have a salic horizon that has its upper boundary within 75 cm of the mineral soil surface.

Salidic Haplustolls

less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. A CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[2] in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a densic, lithic, or paralithic contact if shallower.

Torroxic Haplustolls

HFGH. Other Haplustolls that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[3] in 50 percent or more of the soil volume between a depth of 25 cm from the mineral soil surface and either a depth of 100 cm, or a densic, lithic, or paralithic contact if shallower.

Oxic Haplustolls

HFGI. Other Haplustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haplustolls

HFGJ. Other Haplustolls which have *both*:

1. When neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

---

[2] Some soils with properties that approach those of an oxic horizon do not disperse well. If the ratio of (percent water retained at 1500 kPa tension minus percent organic carbon) to the percentage of measured clay is 0.6 or more, then the percentage of clay is considered to equal either (1) the measured percentage of clay, or (2) three times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever is higher, but no more than 100.[1]

[3] See footnote 2.

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

      (1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

      (2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitritorrandic Haplustolls

HFGK. Other Haplustolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haplustolls

HFGL. Other Haplustolls which have:

1. A mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent; *and*

HFGS. Other Haplustolls which have:

1. When neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Torrifluventic Haplustolls

HFGT. Other Haplustolls which:

1. Have, when neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. *Either*:

   a. Do not have a cambic horizon *and* do not, in any part of the mollic epipedon below 25 cm from the mineral soil surface, meet all the requirements for a cambic horizon except color; *or*

b. Have free carbonates throughout the cambic horizon *or* all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

Torriorthentic Haplustolls

HFGU. Other Haplustolls which have, when neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for six tenths or more of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, remains moist in some or all parts for less than 90 consecutive days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Haplustolls

HFGV. Other Haplustolls which have *both*:

1. *Either* 0.3 percent or more organic carbon at a depth of 125 cm below the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Haplustolls

HFGW. Other Haplustolls which have a brittle horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and contains either some opal coatings or 20 percent or more (by volume) durinodes.

Duric Haplustolls

HFGX. Other Haplustolls which:

1. Have, when neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C; *and*

2. *Either* do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color, *or* have carbonates throughout either the cambic horizon or the lower part of the mollic epipedon.

Udorthentic Haplustolls

HFGY. Other Haplustolls which have, when neither irrigated nor fallowed to store moisture, *either*:

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Haplustolls

HFGZ. Other Haplustolls that *either*:

1. Do not have a cambic horizon *and* do not, in any part of the mollic epipedon below 25 cm from the mineral soil surface, meet all the requirements for a cambic horizon except color; *or*

2. Have free carbonates throughout the cambic horizon *or* all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

Entic Haplustolls

HFGZa. Other Haplustolls.

Typic Haplustolls

Natrustolls

<u>Key to subgroups</u>

HFBA. Natrustolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower; *and*

2. When neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udertic Paleustolls

HFCC. Other Paleustolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Paleustolls

HFCD. Other Paleustolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Paleustolls

HFCE. Other Paleustolls that have a petrocalcic horizon within 150 cm of the mineral soil surface.

Petrocalcic Paleustolls

HFCF. Other Paleustolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Paleustolls

1. A mesic or thermic soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for four tenths or less of the cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Paleustolls

HFCJ. Other Paleustolls which are calcareous throughout after the soil has been mixed to a depth of 18 cm, and have a calcic horizon within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:

1. Sandy or sandy-skeletal and within 100 cm of the mineral soil surface; *or*

2. Clayey, clayey-skeletal, fine, or very fine and within 50 cm of the mineral soil surface; *or*

3. Any other class and within 60 cm of the mineral soil surface.

Calcic Paleustolls

HFCK. Other Paleustolls that are calcareous throughout after the soil has been mixed to a depth of 18 cm.

Entic Paleustolls

HFCL. Other Paleustolls.

Typic Paleustolls

Vermustolls

Key to subgroups

HFFA. Vermustolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Vermustolls

HFFB. Other Vermustolls that have a mollic epipedon 75 cm or more thick.

Pachic Vermustolls

HFFC. Other Vermustolls that have, in one or more horizons within 100 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Vermustolls

HFFD. Other Vermustolls that have a cambic horizon.
Haplic Vermustolls

HFFE. Other Vermustolls that have a mollic epipedon less than 50 cm thick.
Entic Vermustolls

HFFF. Other Vermustolls.
Typic Vermustolls

Xerolls

Key to great groups

HDA. Xerolls that have a duripan within 100 cm of the mineral soil surface.
Durixerolls, p. 457

HDB. Other Xerolls which have a natric horizon, but do not have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.
Natrixerolls, p. 467

HDC. Other Xerolls which have *either*:

1. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface; *or*

2. An argillic horizon that has *one or both* of the following:

   a. *No* clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content within 150 cm of the mineral soil surface (and there is no densic, lithic, or paralithic contact within that depth), *and either*:

      (1) A hue of 7.5YR or redder and a chroma of 5 or more in the matrix; *or*

      (2) Common coarse redox concentrations with a hue of 7.5YR or redder or a chroma of 6 or more, or both; *or*

   b. A clayey or clayey-skeletal particle size in its upper part, and at its upper boundary, a clay increase of either 20 percent or more (absolute) within a vertical distance of 7.5 cm, or of 15 percent or more (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction (and there is no densic, lithic, or paralithic contact within 50 cm of the mineral soil surface).

Palexerolls, p. 468

HDED. Other Argixerolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Argixerolls

HDEE. Other Argixerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Argixerolls

HDEF. Other Argixerolls that have *both*:

1. An aridic moisture regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

      (1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

      (2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitritorrandic Argixerolls

HDEG. Other Argixerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Argixerolls

HDEH. Other Argixerolls which have a mean annual soil temperature lower than 10°C, *and either*:

1. Above the argillic horizon, an albic horizon, *or* a horizon that has color values too high for a mollic epipedon and a chroma too high for an albic horizon; *or*

2. A glossic horizon, *or* interfingering of albic materials into the upper part of the argillic horizon, *or* skeletans of clean silt and sand covering 50 percent or more of the faces of peds in the upper 5 cm of the argillic horizon.

Boralfic Argixerolls

HDEI. Other Argixerolls that have *both*:

1. A calcic horizon or identifiable secondary carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:

   a. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; *or*

   b. Clayey, clayey-skeletal, fine, or very fine and within 90 cm of the mineral soil surface; *or*

   c. Any other class and within 110 cm of the mineral soil surface; *and*

2. A mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Calcic Pachic Argixerolls

HDEJ. Other Argixerolls that have *both*:

1. A mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand; *and*

2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Pachic Ultic Argixerolls

HDEK. Other Argixerolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Argixerolls

HDEL. Other Argixerolls that have *both:*

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Aquultic Argixerolls

HDEM. Other Argixerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Argixerolls

HDEN. Other Argixerolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Argixerolls

HDEO. Other Argixerolls which have *both*:

1. An aridic moisture regime; *and*

2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Argiduridic Argixerolls

HDEP. Other Argixerolls that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Duric Argixerolls

HDDG. Other Calcixerolls that have an aridic moisture regime.

Aridic Calcixerolls

HDDH. Other Calcixerolls which have a mollic epipedon that contains, below any Ap horizon, 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows.

Vermic Calcixerolls

HDDI. Other Calcixerolls.

Typic Calcixerolls

Durixerolls

Key to subgroups

HDAA. Durixerolls which have, above the duripan, *one or both* of the following:

1. Cracks that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick; *or*

2. A linear extensibility of 6.0 cm or more.

Vertic Durixerolls

HDAB. Other Durixerolls that have *both*:

1. An aridic moisture regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

      (1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

      (2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitritorrandic Durixerolls

HDAC. Other Durixerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Durixerolls

HDAD. Other Durixerolls that have, in one or more horizons above the duripan, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Durixerolls

HDAE. Other Durixerolls which have:

1. An aridic moisture regime; *and*

2. An argillic horizon that has a clay increase with depth *either* of 20 percent or more (absolute) within 7.5 cm, *or* of 15 percent or more (absolute) within 2.5 cm; *and*

3. A duripan that is neither very strongly cemented nor indurated in any subhorizon.

Paleargidic Durixerolls

HDAF. Other Durixerolls which have *both*:

1. An aridic moisture regime; *and*

2. An argillic horizon that has a clay increase with depth *either* of 20 percent or more (absolute) within 7.5 cm, *or* of 15 percent or more (absolute) within 2.5 cm.

Abruptic Argiduridic Durixerolls

HDAG. Other Durixerolls which:

1. Have an aridic moisture regime; *and*

2. Do not have an argillic horizon above the duripan; *and*

3. Have a duripan that is neither very strongly cemented nor indurated in any subhorizon.

Cambidic Durixerolls

HDAH. Other Durixerolls which:

1. Have an aridic moisture regime; *and*

2. Do not have an argillic horizon above the duripan.
Haploduridic Durixerolls

HDAI. Other Durixerolls which have;

1. An aridic moisture regime; *and*

2. A duripan that is neither very strongly cemented nor indurated in any subhorizon.
Argidic Durixerolls

HDAJ. Other Durixerolls that have an aridic moisture regime.
Argiduridic Durixerolls

HDAK. Other Durixerolls which have: *both*

1. An argillic horizon that has a clay increase with depth *either* of 20 percent or more (absolute) within 7.5 cm, *or* of 15 percent or more (absolute) within 2.5 cm; *and*

2. A duripan that is neither very strongly cemented nor indurated in any subhorizon.
Haplic Palexerollic Durixerolls

HDAL. Other Durixerolls which have an argillic horizon that has a clay increase with depth *either* of 20 percent or more (absolute) within 7.5 cm, *or* of 15 percent or more (absolute) within 2.5 cm.
Palexerollic Durixerolls

HDAM. Other Durixerolls which:

1. Have a duripan that is neither very strongly cemented nor indurated in any subhorizon; *and*

2. Do not have an argillic horizon above the duripan.
Haplic Haploxerollic Durixerolls

HDAN. Other Durixerolls which do not have an argillic horizon above the duripan.
Haploxerollic Durixerolls

HDAO. Other Durixerolls which have a duripan that is neither very strongly cemented nor indurated in any subhorizon.
Haplic Durixerolls

HDAP. Other Durixerolls.
Typic Durixerolls

Haploxerolls

Key to subgroups

HDFA. Haploxerolls that have *both:*

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either the mineral soil surface or an Ap horizon, whichever is deeper, and the lithic contact.

Lithic Ultic Haploxerolls

HDFB. Other Haploxerolls that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haploxerolls

HDFC. Other Haploxerolls which have *both:*

1. An aridic moisture regime; *and*

2. *One or both* of the following:

   a. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

   b. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Torrertic Haploxerolls

HDFD. Other Haploxerolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Haploxerolls

HDFE. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

   a. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   b. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

      (1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

      (2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitritorrandic Haploxerolls

HDFF. Other Haploxerolls that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, *one or both* of the following:

1. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

2. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Vitrandic Haploxerolls

HDFG. Other Haploxerolls which have:

1. A mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent; *and*

4. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Cumulic Haploxerolls

HDFH. Other Haploxerolls which have:

1. A mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent; *and*

4. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.
Cumulic Ultic Haploxerolls

HDFI. Other Haploxerolls which have:

1. A mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand; *and*

2. An irregular decrease in organic-carbon content from a depth of 25 cm below the mineral soil surface to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.
Cumulic Haploxerolls

HDFJ. Other Haploxerolls that have *both*:

1. A mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand; *and*

2. A calcic horizon or identifiable secondary carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:

   a. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; *or*

   b. Clayey, clayey-skeletal, fine, or very fine and within 90 cm of the mineral soil surface; *or*

c. Any other class and within 110 cm of the mineral soil surface.

Calcic Pachic Haploxerolls

HDFK. Other Haploxerolls that have *both*:

1. A mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand; *and*

2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Pachic Ultic Haploxerolls

HDFL. Other Haploxerolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Haploxerolls

HDFM. Other Haploxerolls that have:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Fluvaquentic Haploxerolls

HDFN. Other Haploxerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A horizon 15 cm or more thick within 100 cm of the mineral soil surface that either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Aquic Duric Haploxerolls

HDFO. Other Haploxerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Aquultic Haploxerolls

HDFP. Other Haploxerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haploxerolls

HDFQ. Other Haploxerolls that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haploxerolls

HDFR. Other Haploxerolls which have:

1. An aridic moisture regime; *and*

2. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of the mineral soil surface, *or* an irregular decrease in organic-carbon content from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

3. A slope of less than 25 percent.

Torrifluventic Haploxerolls

HDFS. Other Haploxerolls which have *both*:

1. An aridic moisture regime; *and*

2. A horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Duridic Haploxerolls

HDFT. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*

2. A calcic horizon or identifiable secondary carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:

   a. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; *or*

   b. Clayey, clayey-skeletal, fine, or very fine and within 90 cm of the mineral soil surface; *or*

   c. Any other class and within 110 cm of the mineral soil surface.

Calcidic Haploxerolls

HDFU. Other Haploxerolls that have *both*:

1. An aridic moisture regime; *and*

2. A sandy particle-size class in all horizons within 100 cm of the mineral soil surface.

Torripsammentic Haploxerolls

HDFV. Other Haploxerolls which:

1. Have an aridic moisture regime; *and*

2. *Either*

   a. Do not have a cambic horizon *and* do not, in any part of the mollic epipedon below 25 cm from the mineral soil surface, meet all the requirements for a cambic horizon except color; *or*

   b. Have free carbonates throughout the cambic horizon *or* all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.

Torriorthentic Haploxerolls

HDFW. Other Haploxerolls that have an aridic moisture regime.

Aridic Haploxerolls

HDFX. Other Haploxerolls that have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Duric Haploxerolls

HDFY. Other Haploxerolls which have *both*:

1. *Either* 0.3 percent or more organic carbon in all horizons within 125 cm of the mineral soil surface, *or* an irregular decrease in organic-carbon content

from a depth of 25 cm to a depth of 125 cm, or to a densic, lithic, or paralithic contact if shallower; *and*

2. A slope of less than 25 percent.

Fluventic Haploxerolls

HDFZ. Other Haploxerolls that have a mollic epipedon which has granular structure and which contains, below any Ap horizon, 50 percent or more (by volume) wormholes, worm casts, or filled animal burrows.

Vermic Haploxerolls

HDFZa. Other Haploxerolls that have a calcic horizon or identifiable secondary carbonates within one of the following particle-size class (by weighted average in the particle-size control section) and depth combinations:

1. Sandy or sandy-skeletal and within 150 cm of the mineral soil surface; *or*

2. Clayey, clayey-skeletal, fine, or very fine and within 90 cm of the mineral soil surface; *or*

3. Any other class and within 110 cm of the mineral soil surface.

Calcic Haploxerolls

HDFZb. Other Haploxerolls which:

1. Do not have a cambic horizon and do not, in the lower part of the mollic epipedon, meet the requirements for a cambic horizon except color; *and*

2. Have a base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Entic Ultic Haploxerolls

HDFZc. Other Haploxerolls that have a base saturation (by sum of cations) of 75 percent or less in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Ultic Haploxerolls

HDFZd. Other Haploxerolls that *either*:

1. Do not have a cambic horizon *and* do not, in any part of the mollic epipedon below 25 cm from the mineral soil surface, meet all the requirements for a cambic horizon except color; *or*

2. Have free carbonates throughout the cambic horizon *or* all parts of the mollic epipedon below a depth of 25 cm from the mineral soil surface.
Entic Haploxerolls

HDFZe. Other Haploxerolls.
Typic Haploxerolls

Natrixerolls

Key to subgroups

HDBA. Natrixerolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.
Vertic Natrixerolls

HDBB. Other Natrixerolls that have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. A horizon 15 cm or more thick within 100 cm of the mineral soil surface that either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.
Aquic Duric Natrixerolls

HDBC. Other Natrixerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Natrixerolls

HDBD. Other Natrixerolls that have an aridic moisture regime.
Aridic Natrixerolls

HDBE. Other Natrixerolls which have a horizon within 100 cm of the mineral soil surface that is 15 cm or more thick and either contains 20 percent or more (by volume) durinodes or is brittle and has firm consistence when moist.

Duric Natrixerolls

HDBF. Other Natrixerolls.

Typic Natrixerolls

Palexerolls

Key to subgroups

HDCA. Palexerolls that have a natric horizon.

Natric Palexerolls

HDCB. Other Palexerolls which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Palexerolls

HDCC. Other Palexerolls that have a mollic epipedon 50 cm or more thick with a texture finer than loamy fine sand.

Pachic Palexerolls

HDCD. Other Palexerolls that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Palexerolls

HDCE. Other Palexerolls which have *both*:

1. An aridic moisture regime; *and*

2. A petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcidic Palexerolls

HDCF. Other Palexerolls that have an aridic moisture regime.

Aridic Palexerolls

HDCG. Other Palexerolls which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Palexerolls

HDCH. Other Palexerolls that have a base saturation of 75 percent or less in one or more subhorizons either within the argillic horizon if more than 50 cm thick, or within its upper 50 cm.

Ultic Palexerolls

HDCI. Other Palexerolls which have an argillic horizon that has *either*:

1. Less than 35 percent clay in the upper part; *or*

2. At its upper boundary, has a clay increase that is *both* less than 20 percent (absolute) within a vertical distance of 7.5 cm, *and* is less than 15 percent (absolute) within a vertical distance of 2.5 cm, in the fine-earth fraction.

Haplic Palexerolls

HDCJ. Other Palexerolls.

Typic Palexerolls

CHAPTER 12

OXISOLS[1]

Key to suborders

DA. Oxisols that have aquic conditions for some time in most years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface, *and one or more* of the following:

1. A histic epipedon; *or*

2. An epipedon with a color value, moist, of 3 or less, and directly below it, a horizon with a chroma of 2 or less; *or*

3. Distinct or prominent redox concentrations within 50 cm of the mineral soil surface, an epipedon, and directly below it, a horizon with *one or both* of the following:

    a. Fifty percent or more hue of 2.5Y or yellower; *or*

    b. A chroma of 3 or less; *or*

4. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquox, p. 472

DB. Other Oxisols that have an aridic moisture regime.

Torrox, p. 482

DC. Other Oxisols that have an ustic or a xeric moisture regime.

Ustox, **p. 493**

DD. Other Oxisols that have a perudic moisture regime.

Perox, p. 473

DE. Other Oxisols.

Udox, p.484

[1] This chapter on Oxisols was rewritten in 1987 following the recommendations of the International Committee on the Classification of Oxisols (ICOMOX), chaired by Hari Eswaran from 1978 to 1981 and then by S.W Buol until the completion of the task in 1987.

Aquox

Key to great groups

DAA. Aquox that have, in one or more subhorizons of the oxic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.

Acraquox, p.472

DAB. Other Aquox that have plinthite forming a continuous phase within 125 cm of the mineral soil surface.

Plinthaquox, p.473

DAC. Other Aquox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutraquox, p.472

DAD. Other Aquox.

Haplaquox, p.473

Acraquox

Key to subgroups

DAAA. Acraquox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Acraquox

DAAB. Other Acraquox which have, directly below an epipedon, a horizon 10 cm or more thick that has 50 percent or more chroma of 3 or more.

Aeric Acraquox

DAAC. Other Acraquox.

Typic Acraquox

Eutraquox

Key to subgroups

DACA. Eutraquox that have a histic epipedon.

Histic Eutraquox

DACB. Other Eutraquox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.
Plinthic Eutraquox

DACC. Other Eutraquox which have, directly below an epipedon, a horizon 10 cm or more thick that has 50 percent or more chroma of 3 or more.

Aeric Eutraquox

DACD. Other Eutraquox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Eutraquox

DACE. Other Eutraquox.

Typic Eutraquox

Haplaquox

Key to subgroups

DADA. Haplaquox that have a histic epipedon.

Histic Haplaquox

DADB. Other Haplaquox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Haplaquox

DADC. Other Haplaquox which have, directly below an epipedon, a horizon 10 cm or more thick that has 50 percent or more chroma of 3 or more.

Aeric Haplaquox

DADD. Other Haplaquox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Haplaquox

DADE. Other Haplaquox.

Typic Haplaquox

Plinthaquox

Key to subgroups

DABA. Plinthaquox which have, directly below an epipedon, a horizon 10 cm or more thick that has 50 percent or more chroma of 3 or more.

Aeric Plinthaquox

DABB. Other Plinthaquox.

Typic Plinthaquox

Perox

Key to great groups

DDA. Perox that have a sombric horizon within 150 cm of the mineral soil surface.

Sombriperox, p. 482

DDB. Other Perox that have, in one or more subhorizons of the oxic or kandic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (*in* 1N KCl) *of* 5.0 or more.

Acroperox, p. 474

DDC. Other Perox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutroperox, p. 476

DDD. Other Perox which have *both*:

1. A clay content of 40 percent or more between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Kandiperox, p. 480

DDE. Other Perox.

Haploperox, p. 478

Acroperox

Key to subgroups

DDBA. Acroperox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Acroperox

DDBB. Other Acroperox that have a petroferric contact within 125 cm of the soil surface.

Petroferric Acroperox

DDBC. Other Acroperox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Acroperox

DDBD. Other Acroperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Acroperox

DDBE. Other Acroperox that have a delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick within 125 cm of the mineral soil surface.

Anionic Acroperox

DDBF. Other Acroperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Acroperox

DDBG. Other Acroperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Acroperox

DDBH. Other Acroperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less.

Humic Rhodic Acroperox

DDBI. Other Acroperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Acroperox

DDBJ. Other Acroperox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Acroperox

DDBK. Other Acroperox that have in *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less.

Rhodic Acroperox

DDBL. Other Acroperox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Acroperox

DDBM. Other Acroperox.

Typic Acroperox

Eutroperox

Key to subgroups

DDCA. Eutroperox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Eutroperox

DDCB. Other Eutroperox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Eutroperox

DDCC. Other Eutroperox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Eutroperox

DDCD. Other Eutroperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Eutroperox

DDCE. Other Eutroperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Eutroperox

DDCF. Other Eutroperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Eutroperox

DDCG. Other Eutroperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Eutroperox

DDCH. Other Eutroperox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Kandiudalfic Eutroperox

DDCI. Other Eutroperox which have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. An oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Umbreptic Eutroperox

DDCJ. Other Eutroperox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Eutroperox

DDCK. Other Eutroperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less.

Humic Rhodic Eutroperox

DDCL. Other Eutroperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Eutroperox

DDCM. Other Eutroperox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Eutroperox

DDCN. Other Eutroperox that have *in all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less.

Rhodic Eutroperox

DDCO. Other Eutroperox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Eutroperox

DDCP. Other Eutroperox.

Typic Eutroperox

Haploperox

Key to subgroups

DDEA. Haploperox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Haploperox

DDEB. Other Haploperox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Haploperox

DDEC. Other Haploperox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Haploperox

DDED. Other Haploperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Haploperox

DDEE. Other Haploperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Haploperox

DDEF. Other Haploperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Haploperox

DDEG. Other Haploperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haploperox

DDEH. Other Haploperox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haploperox

DDEI. Other Haploperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less.

Humic Rhodic Haploperox

DDEJ. Other Haploperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Haploperox

DDEK. Other Haploperox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Haploperox

DDEL. Other Haploperox that have in *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less.

Rhodic Haploperox

DDEM. Other Haploperox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Haploperox

DDEN. Other Haploperox.

Typic Haploperox

Kandiperox

Key to subgroups

DDDA. Kandiperox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Kandiperox

DDDB. Other Kandiperox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Kandiperox

DDDC. Other Kandiperox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Kandiperox

DDDD. Other Kandiperox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Kandiperox

DDDE. Other Kandiperox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Kandiperox

DDDF. Other Kandiperox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Kandiperox

DDDG. Other Kandiperox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiperox

DDDH. Other Kandiperox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandiperox

DDDI. Other Kandiperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less.

Humic Rhodic Kandiperox

DDDJ. Other Kandiperox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

DBB. Other Torrox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.
Eutrotorrox, p. 483

DBC. Other Torrox.
Haplotorrox, p. 483

Acrotorrox

Key to subgroups

DBAA. Acrotorrox that have a petroferric contact within 125 cm of the mineral soil surface.
Petroferric Acrotorrox

DBAB. Other Acrotorrox that have a lithic contact within 125 cm of the mineral soil surface.
Lithic Acrotorrox

DBAC. Other Acrotorrox.
Typic Acrotorrox

Eutrotorrox

Key to subgroups

DBBA. Eutrotorrox that have a petroferric contact within 125 cm of the mineral soil surface.
Petroferric Eutrotorrox

DBBB. Other Eutrotorrox that have a lithic contact within 125 cm of the mineral soil surface.
Lithic Eutrotorrox

DBBC. Other Eutrotorrox.
Typic Eutrotorrox

Haplotorrox

Key to subgroups

DBCA. Haplotorrox that have a petroferric contact within 125 cm of the mineral soil surface.
Petroferric Haplotorrox

DBCB. Other Haplotorrox that have a lithic contact within 125 cm of the mineral soil surface.
Lithic Haplotorrox

DBCC. Other Haplotorrox.
Typic Haplotorrox

Udox

Key to great groups

DEA. Udox that have a sombric horizon within 150 cm of the mineral soil surface.

Sombriudox, p. 493

DEB. Other Udox that have, in one or more subhorizons of the oxic or kandic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.

Acrudox, p. 484

DEC. Other Udox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutrudox, p. 486

DED. Other Udox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Kandiudox, p. 491

DEE. Other Udox.

Hapludox, p. 489

Acrudox

Key to subgroups

DEBA. Acrudox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Acrudox

DEBB. Other Acrudox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Acrudox

DEBC. Other Acrudox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Acrudox

DEBD. Other Acrudox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Acrudox

DEBE. Other Acrudox that have, within 125 cm of the mineral soil surface, *both*:

1. A delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Anionic Aquic Acrudox

DEBF. Other Acrudox that have a delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick within 125 cm of the mineral soil surface.

Anionic Acrudox

DEBG. Other Acrudox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Acrudox

DEBH. Other Acrudox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Acrudox

DEBI. Other Acrudox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutric Acrudox

DEBJ. Other Acrudox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

DECB. Other Eutrudox that have a petroferric contact within 125 cm of the mineral soil surface.
Petroferric Eutrudox

DECC. Other Eutrudox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Lithic Eutrudox

DECD. Other Eutrudox that have a lithic contact within 125 cm of the mineral soil surface.
Lithic Eutrudox

DECE. Other Eutrudox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Plinthaquic Eutrudox

DECF. Other Eutrudox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.
Plinthic Eutrudox

DECG. Other Eutrudox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Eutrudox

DECH. Other Eutrudox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.
Kandiudalfic Eutrudox

DECI. Other Eutrudox which have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. An oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Umbreptic Eutrudox

DECJ. Other Eutrudox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Eutrudox

DECK. Other Eutrudox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less.

Humic Rhodic Eutrudox

DECL. Other Eutrudox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Eutrudox

DECM. Other Eutrudox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Eutrudox

DECN. Other Eutrudox that have in *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less.

Rhodic Eutrudox

DECO. Other Eutrudox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Eutrudox

DECP. Other Eutrudox.

Typic Eutrudox

Hapludox

Key to subgroups

DEEA. Hapludox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Hapludox

DEEB. Other Hapludox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Hapludox

DEEC. Other Hapludox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Hapludox

DEED. Other Hapludox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Hapludox

DEEE. Other Hapludox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Hapludox

DEEF. Other Hapludox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Hapludox

DEEG. Other Hapludox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Hapludox

DEEH. Other Hapludox which have an *oxic horizon* that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Hapludox

DEEI. Other Hapludox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Hapludox

DEEJ. Other Hapludox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less.

Humic Rhodic Hapludox

DEEK. Other Hapludox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Hapludox

DEEL. Other Hapludox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Hapludox

DEEM. Other Hapludox that have in *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less.

Rhodic Hapludox

DEEN. Other Hapludox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Hapludox

DEEO. Other Hapludox.

Typic Hapludox

Kandiudox

Key to subgroups

DEDA. Kandiudox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Kandiudo

DEDB. Other Kandiudox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Kandiudox

DEDC. Other Kandiudox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Kandiudox

DEDD. Other Kandiudox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Kandiudox

DEDE. Other Kandiudox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Kandiudox

DEDF. Other Kandiudox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Kandiudox

DEDG. Other Kandiudox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiudox

DEDH. Other Kandiudox that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandiudox

DEDI. Other Kandiudox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less.

Humic Rhodic Kandiudox

DEDJ. Other Kandiudox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Kandiudox

DEDK. Other Kandiudox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Kandiudox

DEDL. Other Kandiudox that have in *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less.

Rhodic Kandiudox

DEDM. Other Kandiudox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Kandiudox

DEDN. Other Kandiudox.

Typic Kandiudox

Sombriudox

Key to subgroups

DEAA. Sombriudox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Sombriudox

DEAB. Other Sombriudox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Sombriudox

DEAC. Other Sombriudox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Sombriudox

DEAD. Other Sombriudox.

Typic Sombriudox

Ustox

Key to great groups

DCA. Ustox that have a sombric horizon within 150 cm of the mineral soil surface.

Sombriustox, p. 502

DCB. Other Ustox that have, in one or more subhorizons of the oxic or kandic horizon within 150 cm of the mineral soil surface, an ECEC of less than 1.50 cmol(+)/kg clay and a pH value (in 1N KCl) of 5.0 or more.

Acrustox, p. 494

DCC. Other Ustox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutrustox, p. 496

DCD. Other Ustox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.
Kandiustox, p. 500

DCE. Other Ustox.
Haplustox, p. 498

Acrustox

Key to subgroups

DCBA. Acrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Petroferric Acrustox

DCBB. Other Acrustox that have a petroferric contact within 125 cm of the mineral soil surface.
Petroferric Acrustox

DCBC. Other Acrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Lithic Acrustox

DCBD. Other Acrustox that have a lithic contact within 125 cm of the mineral soil surface.
Lithic Acrustox

DCBE. Other Acrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Anionic Aquic Acrustox

DCBF. Other Acrustox that have a delta pH (KCl pH minus 1:1 water pH) with a 0 or net positive charge in a layer 18 cm or more thick within a depth of 125 cm of the soil surface.

Anionic Acrustox

DCBG. Other Acrustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Acrustox

DCBH. Other Acrustox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Acrustox

DCBI. Other Acrustox that have a base saturation (by NH_4OAc) of 35 percent or more in all horizons within 125 cm of the mineral soil surface.

Eutric Acrustox

DCBJ. Other Acrustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less.

Humic Rhodic Acrustox

DCBK. Other Acrustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Acrustox

DCBL. Other Acrustox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Acrustox

DCBM. Other Acrustox that have in *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less.

Rhodic Acrustox

DCBN. Other Acrustox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Acrustox

DCBO. Other Acrustox.

Typic Acrustox

Eutrustox

Key to subgroups

DCCA. Eutrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Eutrustox

DCCB. Other Eutrustox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Eutrustox

DCCC. Other Eutrustox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Eutrustox

DCCD. Other Eutrustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Eutrustox

DCCE. Other Eutrustox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Eutrustox

DCCF. Other Eutrustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Eutrustox

DCCG. Other Eutrustox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Eutrustox

DCCH. Other Eutrustox that have *both*:

1. A clay content of 40 percent or more in the fine-earth fraction between the soil surface and a depth of 18 cm, after mixing; *and*

2. A kandic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Kandiustalfic Eutrustox

DCCI. Other Eutrustox which have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. An oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Umbreptic Eutrustox

DCCJ. Other Eutrustox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Eutrustox

DCCK. Other Eutrustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less.

Humic Rhodic Eutrustox

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Haplustox

DCED. Other Haplustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Haplustox

DCEE. Other Haplustox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Haplustox

DCEF. Other Haplustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Haplustox

DCEG. Other Haplustox that have, within 125 cm of the mineral soil surface, *both*:

1. The lower boundary of the oxic horizon; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aqueptic Haplustox

DCEH. Other Haplustox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haplustox

DCEI. Other Haplustox that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haplustox

DCEJ. Other Haplustox which have an oxic horizon that has its lower boundary within 125 cm of the mineral soil surface.

Inceptic Haplustox

DCEK. Other Haplustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less.

Humic Rhodic Haplustox

DCEL. Other Haplustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Haplustox

DCEM. Other Haplustox that have 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Haplustox

DCEN. Other Haplustox that have in *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less.

Rhodic Haplustox

DCEO. Other Haplustox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Haplustox

DCEP. Other Haplustox.

Typic Haplustox

Kandiustox

Key to subgroups

DCDA. Kandiustox that have, within 125 cm of the mineral soil surface, *both*:

1. A petroferric contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Petroferric Kandiustox

DCDB. Other Kandiustox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Kandiustox

DCDC. Other Kandiustox that have, within 125 cm of the mineral soil surface, *both*:

1. A lithic contact; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Lithic Kandiustox

DCDD. Other Kandiustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Kandiustox

DCDE. Other Kandiustox that have, in one or more horizons within 125 cm of the mineral soil surface, *both*:

1. Five percent or more (by volume) plinthite; *and*

2. Redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Kandiustox

DCDF. Other Kandiustox that have 5 percent or more (by volume) plinthite in one or more horizons within 125 cm of the mineral soil surface.

Plinthic Kandiustox

DCDG. Other Kandiustox that have, in one or more horizons within 125 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiustox

DCDH. Other Kandiustox that have *both*:

1. 16 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. In *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

a. A hue of 2.5YR or redder; *and*

b. A value moist of 3 or less.

Humic Rhodic Kandiustox

DCDI. Other Kandiustox that have *both*:

1. 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm; *and*

2. Fifty percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Humic Xanthic Kandiustox

DCDJ. Other Kandiustox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Kandiustox

DCDK. Other Kandiustox that have in *all* horizons between 25 and 125 cm from the mineral soil surface, more than 50 percent colors that have *both* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less.

Rhodic Kandiustox

DCDL. Other Kandiustox that have 50 percent or more hue of 7.5YR or yellower and color value, moist, of 6 or more between 25 and 125 cm from the mineral soil surface.

Xanthic Kandiustox

DCDM. Other Kandiustox.

Typic Kandiustox

Sombriustox

Key to subgroups

DCAA. Sombriustox that have a petroferric contact within 125 cm of the mineral soil surface.

Petroferric Sombriustox

DCAB. Other Sombriustox that have a lithic contact within 125 cm of the mineral soil surface.

Lithic Sombriustox

DCAC. Other Sombriustox that have 16 kg/m² or more organic carbon between the mineral soil surface and a depth of 100 cm.

Humic Sombriustox

DCAD. Other Sombriustox.

Typic Sombriustox

CHAPTER 13

SPODOSOLS[1]

Key to suborders

BA. Spodosols that have aquic conditions for some time in most years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface, *and one or both* of the following:

1. A histic epipedon; *or*

2. Within 50 cm of the mineral soil surface, redoximorphic features in an albic or a spodic horizon.

Aquods, p.503

BB. Other Spodosols that have a cryic or pergelic soil temperature regime.

Cryods, p. 508

BC. Other Spodosols that have 6.0 percent or more organic carbon in a layer 10 cm or more thick within the spodic horizon.

Humods, p. 511

BD. Other Spodosols.

Orthods, p. 513

Aquods

Key to great groups

BAA. Aquods that have a cryic or pergelic soil temperature regime.

Cryaquods, p.505

BAB. Other Aquods that have less than 0.10 percent iron (by ammonium oxalate) in 75 percent or more of the spodic horizon.

Alaquods, **p. 504**

SPO

BAC. Other Aquods that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.

Fragiaquods, p. 507

[1] This chapter on Spodosols was rewritten in 1992 following the recommendations of the International Committee on the Classification of Spodosols (ICOMOD), chaired initially by F. Ted Miller, then by Robert V. Rourke (Since 1986).

BAD. Other Aquods that have a placic horizon within 100 cm of the mineral soil surface in 50 percent or more of each pedon.

Placaquods, p. 508

BAE. Other Aquods which have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air-drying and has its upper boundary within 100 cm of the mineral soil surface.

Duraquods, p. 506

BAF. Other Aquods that have episaturation.

Epiaquods, p.507

BAG. Other Aquods.

Endoaquods, p.506

Alaquods

Key to subgroups

BABA. Alaquods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Alaquods

BABB. Other Alaquods which have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air-drying and has its upper boundary within 100 cm of the mineral soil surface.

Duric Alaquods

BABC. Other Alaquods that have a histic epipedon.

Histic Alaquods

BABD. Other Alaquods which have *both*:

1. Within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part; *and*

2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm.

Alfic Arenic Alaquods

BABE. Other Alaquods that have *both*:

1. An argillic or a kandic horizon within 200 cm of the mineral soil surface; *and*

2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm.

Arenic Ultic Alaquods

BABF. Other Alaquods that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm.

Arenic Alaquods

BABG. Other Alaquods that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 125 cm or more.

Grossarenic Alaquods

BABH. Other Alaquods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Alaquods

BABI. Other Alaquods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

Ultic Alaquods

BABJ. Other Alaquods that have an ochric epipedon.

Aeric Alaquods

BABK. Other Alaquods.

Typic Alaquods

Cryaquods

Key to subgroups

BAAA. Cryaquods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Cryaquods

BAAB. Other Cryaquods that have a mean annual soil temperature of 0°C or less.

Pergelic Cryaquods

BAAC. Other Cryaquods that have a placic horizon within 100 cm of the mineral soil surface in 50 percent or more of each pedon.

Placic Cryaquods

BAAD. Other Cryaquods which have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air-drying and has its upper boundary within 100 cm of the mineral soil surface.

Duric Cryaquods

BAAE. Other Cryaquods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Cryaquods

Epiaquods

Key to subgroups

BAFA. Epiaquods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Epiaquods

BAFB. Other Epiaquods that have a histic epipedon.

Histic Epiaquods

BAFC. Other Epiaquods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Epiaquods

BAFD. Other Epiaquods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35†percent or more (by sum of cations) in some part.

Alfic Epiaquods

BAFE. Other Epiaquods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

Ultic Epiaquods

BAFF. Other Epiaquods that have an umbric epipedon.

Umbric Epiaquods

BAFG. Other Epiaquods.

Typic Epiaquods

Fragiaquods

Key to subgroups

BACA. Fragiaquods that have a histic epipedon.

Histic Fragiaquods

SPO

BACB. Other Fragiaquods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Fragiaquods

BACC. Other Fragiaquods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon.

Argic Fragiaquods

BACD. Other Fragiaquods.

Typic Fragiaquods

Placaquods

Key to subgroups

BADA. Placaquods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Placaquods

BADB. Other Placaquods.

Typic Placaquods

Cryods

Key to great groups

BBA. Cryods that have a placic horizon within 100 cm of the mineral soil surface in 50†percent or more of each pedon.

Placocryods, p. 511

BBB. Other Cryods which have, in 90†percent or more of each pedon, a cemented soil layer that does not slake in water after air-drying and has its upper boundary within 100 cm of the mineral soil surface.

Duricryods, p. 508

BBC. Other Cryods that have 6.0 percent or more organic carbon throughout a layer 10†cm or more thick within the spodic horizon.

Humicryods, p. 510

BBD. Other Cryods.

Haplocryods, p. 509

Duricryods

Key to subgroups

BBBA. Duricryods which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Aquandic Duricryods

BBBB. Other Duricryods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Duricryods

BBBC. Other Duricryods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Duricryods

BBBD. Other Duricryods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Duricryods

BBBE. Other Duricryods that have 6.0 percent or more organic carbon throughout a layer 10 cm or more thick within the spodic horizon.

Humic Duricryods

BBBF. Other Duricryods.

Typic Duricryods

Haplocryods

Key to subgroups

BBDA. Haplocryods that have a lithic contact within 50†cm of the mineral soil surface.

Lithic Haplocryods

BBDB. Other Haplocryods that have a mean annual soil temperature of 0°C or less.

Pergelic Haplocryods

BBDC. Other Haplocryods which have *both*:

1. In one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Aquandic Haplocryods

BBDD. Other Haplocryods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the

Durihumods

Key to subgroups

BCBA. Durihumods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Durihumods

BCBB. Other Durihumods.

Typic Durihumods

Fragihumods

Key to subgroups

BCCA. All Fragihumods (provisionally).

Typic Fragihumods

Haplohumods

Key to subgroups

BCDA. Haplohumods that have a lithic contact within 50†cm of the mineral soil surface.

Lithic Haplohumods

BCDB. Other Haplohumods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Haplohumods

BCDC. Other Haplohumods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Haplohumods

BCDD. Other Haplohumods.

Typic Haplohumods

Placohumods

BCAA. Placohumods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.
Andic Placohumods

BCAB. Other Placohumods.

Typic Placohumods

Orthods

Key to great groups

BDA. Orthods that have, in 50†percent or more of each pedon, a placic horizon within 100 cm of the mineral soil surface.

Placorthods, p. 519

BDB. Other Orthods which have, in 90 percent or more of each pedon, a cemented soil layer that does not slake in water after air-drying and has its upper boundary within 100 cm of the mineral soil surface.

Durorthods, p. 514

BDC. Other Orthods that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.

Fragiorthods, p. 515

BDD. Other Orthods that have less than 0.10 percent iron (by ammonium oxalate) in 75 percent or more of the spodic horizon.

Alorthods, p. 513

BDE. Other Orthods.

Haplorthods, p. 516

Alorthods

Key to subgroups

BDDA. Alorthods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Alorthods

BDDB. Other Alorthods that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm; *and*

2. An argillic or a kandic horizon below the spodic horizon.

Arenic Ultic Alorthods

BDDC. Other Alorthods that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 75 to 125 cm.

Arenic Alorthods

BDDD. Other Alorthods that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 125 cm or more; *and*

2. In 10 percent or more of each pedon, less than 3.0 percent organic carbon in the upper 2 cm of the spodic horizon.

Entic Grossarenic Alorthods

BDDE. Other Alorthods that have, in 10 percent or more of each pedon, less than 3.0 percent organic carbon in the upper 2 cm of the spodic horizon.

Entic Alorthods

BDDF. Other Alorthods that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of the spodic horizon at a depth of 125 cm or more.

Grossarenic Alorthods

BDDG. Other Alorthods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Alorthods

BDDH. Other Alorthods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Alorthods

BDDI. Other Alorthods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

Ultic Alorthods

BDDJ. Other Alorthods.

Typic Alorthods

Durorthods

Key to subgroups

BDBA. Durorthods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Durorthods

BDBB. Other Durorthods.

Typic Durorthods

Fragiorthods

Key to subgroups

BDCA. Fragiorthods that have, in one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Fragiorthods

BDCB. Other Fragiorthods that:

1. Are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years; *and*

2. Have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Oxyaquic Fragiorthods

BDCC. Other Fragiorthods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Fragiorthods

BDCD. Other Fragiorthods which have a surface horizon 30 cm or more thick that meets all the requirements for a plaggen epipedon except thickness.

Plaggeptic Fragiorthods

BDCE. Other Fragiorthods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Fragiorthods

BDCF. Other Fragiorthods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

Ultic Fragiorthods

BDCG. Other Fragiorthods which have a spodic horizon that has *one* of the following:

1. A texture in some part of very fine sand, loamy very fine sand, or finer: *and*

   a. A thickness of 10 cm or less; *and*

   b. A weighted average of less than 1.2 percent organic carbon; *and*

c. Within the upper 7.5 cm, either or both a moist color value or chroma of 4 or more (crushed and smoothed sample); *or*

2. A texture in all parts of loamy fine sand, fine sand, or coarser *and either or both,* a moist color value *or* chroma of 4 or more (crushed and smoothed sample) in the upper 2.5 cm.

Entic Fragiorthods

BDCH. Other Fragiorthods.

Typic Fragiorthods

Haplorthods

Key to subgroups

BDEA. Haplorthods which have a lithic contact within 50 cm of the mineral soil surface; *and either*

1. A spodic horizon with a texture in some part of very fine sand, loamy very fine sand, or finer: *and*

   a. A thickness of 10 cm or less; *and*

   b. A weighted average of less than 1.2 percent organic carbon; *and*

   c. Within the upper 7.5 cm, *either or both* a moist color value *or* chroma of 4 or more (crushed and smoothed sample); *or*

2. A spodic horizon with a texture in all parts of loamy fine sand, fine sand, or coarser *and either or both,* a moist color value *or* chroma of 4 or more (crushed and smoothed sample) in the upper 2.5 cm.

Entic Lithic Haplorthods

BDEB. Other Haplorthods that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplorthods

BDEC. Other Haplorthods that have *both*:

1. Fragic soil properties;

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more horizons within 75 cm of the mineral soil surface, redoximorphic features, and also aquic conditions for some time in most years (or artificial drainage).

Fragiaquic Haplorthods

BDEH. Other Haplorthods that have:

1. Within 200 cm of the mineral soil surface, an argillic or a kandic horizon; *and*

2. Saturation with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Ultic Haplorthods

BDEI. Other Haplorthods that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Haplorthods

BDEJ. Other Haplorthods that have below the spodic, but not above an argillic horizon, lamellae (two or more) within 200 cm of the mineral soil surface.

Lamellic Haplorthods

BDEK. Other Haplorthods that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Haplorthods

BDEL. Other Haplorthods which have andic soil properties throughout horizons that have a total thickness of 25 cm or more within 75 cm either of the mineral soil surface, or of the top of an organic layer with andic soil properties, whichever is shallower.

Andic Haplorthods

BDEM. Other Haplorthods which have, within 200 cm of the mineral soil surface, an argillic or a kandic horizon that has a base saturation of 35 percent or more (by sum of cations) in some part.

Alfic Haplorthods

BDEN. Other Haplorthods that have an argillic or a kandic horizon within 200 cm of the mineral soil surface.

Ultic Haplorthods

BDEO. Other Haplorthods which have a spodic horizon that has *one* of the following:

1. A texture in some part of very fine sand, loamy very fine sand, or finer: *and*

   a. A thickness of 10 cm or less; *and*

   b. A weighted average of less than 1.2 percent organic carbon; *and*

   c. Within the upper 7.5 cm, either or both a moist color value or chroma of 4 or more (crushed and smoothed sample); *or*

2. A texture in all parts of loamy fine sand, fine sand, or coarser *and either or both*, a moist color value *or* chroma of 4 or more (crushed and smoothed sample) in the upper 2.5 cm.

Entic Haplorthods

BDEP. Other Haplorthods.

Typic Haplorthods

Placorthods

Key to subgroups

BDAA. All Placorthods (provisionally).

Typic Placorthods

CHAPTER 14

ULTISOLS

<u>Key to suborders</u>

GA. Ultisols that have acquic conditions for some time in most years (or artificial drainange) in one or more horizons within 50 cm of the mineral soil surface, *and one or both* of the following:

1. Redoximorphic features in all layers between either the lower boundary of an Ap horizon or a depth of 25cm from the mineral soil surface, whichever is deeper, and a depth of 40 cm; *and one* of the following within the upper 12.5 cm of the argillic or kandic horizon:

    a. Redox concentrations, and 50 percent or more redox depletions with a chroma of 2 or less either on faces of peds or in the matrix; *or*

    b. Fifty percent or more redox depletions with a chroma of 1 or less either on faces of peds or in the matrix; *or*

    c. Distinct or prominent redox concentrations and 50 percent or more hue of 2.5Y or 5Y in the matrix, *and also* a thermic, isothermic, or warmer soil temperature regime; *or*

2. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to *a,a'*-dipyridyl at a time when the soil is not being irrigated.

Aquults, p. 522

GB. Other Ultisols that have *one or both* of the foll *d*1

feeaeɪ ere an oUhn

GAF. Other Aquults which:

1. Do not have a densic, lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Within 150 cm of the mineral soil surface, *either*:

   a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

   b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

Paleaquults, p. 528

GAG. Other Aquults that have an umbric or a mollic epipedon.

Umbraquults, p. 530

GAH. Other Aquults that have episaturation.

Epiaquults, p. 524

GAI. Other Aquults.

Endoaquults, p. 524

Albaquults

<u>Key to subgroups</u>

GACA. Albaquults which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Albaquults

GACB. Other Albaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25†cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Albaquults

GACC. Other Albaquults.

Typic Albaquults

Endoaquults

Key to subgroups

GAIA. Endoaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Endoaquults

GAIB. Other Endoaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Endoaquults

GAIC. Other Endoaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Endoaquults

GAID. Other Endoaquults.

Typic Endoaquults

Epiaquults

Key to subgroups

GAHA. Epiaquults that have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Epiaquults

GAHB. Other Epiaquults that have:

1. Fragic soil properties;

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. Fifty percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.
Aeric Fragic Epiaquults

GAHC. Other Epiaquults that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.
Fragic Epiaquults

GAHD. Other Epiaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.
Arenic Epiaquults

GAHE. Other Epiaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.
Grossarenic Epiaquults

GAHF. Other Epiaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.
Aeric Epiaquults

GAHG. Other Epiaquults.
Typic Epiaquults

Fragiaquults

Key to subgroups

GABA. Fragiaquults that have *both*:

1. Fifty percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and the fragipan; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
Aeric Plinthic Fragiaquults

GADE. Other Kandiaquults that have a sandy or sandy-skeletal particle-size throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 100 cm or more.

Grossarenic Kandiaquults

GADF. Other Kandiaquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiaquults

GADG. Other Kandiaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25†cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Kandiaquults

GADH. Other Kandiaquults that do not have an ochric epipedon.

Umbric Kandiaquults

GADI. Other Kandiaquults.

Typic Kandiaquults

Kanhaplaquults

Key to subgroups

GAEA. Kanhaplaquults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface one or more of the following:

1. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

2. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

3. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

   a. In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

   b. [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Kanhaplaquults

GAEB. Other Kanhaplaquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
Plinthic Kanhaplaquults

GAEC. Other Kanhaplaquults which:

1. Do not have an ochric epipedon; *and*

2. Have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.
Aeric Umbric Kanhaplaquults

GAED. Other Kanhaplaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25†cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.
Aeric Kanhaplaquults

GAEE. Other Kanhaplaquults that do not have an ochric epipedon.
Umbric Kanhaplaquults

GAEF. Other Kanhaplaquults.
Typic Kanhaplaquults

Paleaquults

Key to subgroups

GAFA. Paleaquults which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.
Vertic Paleaquults

GAFB. Other Paleaquults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Paleaquults

GAFC. Other Paleaquults which:

1. Do not have an ochric epipedon; *and*

2. Have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Umbric Paleaquults

GAFD. Other Paleaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleaquults

GAFE. Other Paleaquults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleaquults

GAFF. Other Paleaquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Paleaquults

GAFG. Other Paleaquults that have 50 percent or more chroma of 3 or more in one or more horizons between either the A or Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm.

Aeric Paleaquults

GAFH. Other Paleaquults that do not have an ochric epipedon.

Umbric Paleaquults

GAFI. Other Paleaquults.

Typic Paleaquults

Plinthaquults

Key to subgroups

GAAA. Plinthaquults that have a CEC (by 1N NH_4OAc pH 7) of less than 24 cmol(+)/kg clay[1] in 50 percent or more (by volume) of the argillic horizon if less than 100 cm thick, or of its upper 100 cm.

Kandic Plinthaquults

GAAB. Other Plinthaquults.

Typic Plinthaquults

Umbraquults

Key to subgroups

GAGA. Umbraquults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Umbraquults

GAGB. Other Umbraquults.

Typic Umbraquults

Humults

Key to great groups

GBA. Humults that have a sombric horizon within 100 cm of the mineral soil surface.

Sombrihumults, p. 536

GBB. Other Humults that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.

Plinthohumults, p. 535

GBC. Other Humults which:

1. Do not have a densic, lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

---

[1] Some soils with properties that approach those of an oxic horizon do not disperse well. If the ratio of (water retained at 1500 kPa tension minus percent organic carbon) to the percentage of measured clay is 0.6 or more, then the percentage of clay is considered to equal either (1) the measured percentage of clay, or (2) three times (percent water retained at 1500 kPa tension minus percent organic carbon), whichever value is higher, but no more than 100.

Haplohumults

Key to subgroups

GBFA. Haplohumults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplohumults

GBFB. Other Haplohumults that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Haplohumults

GBFC. Other Haplohumults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Haplohumults

GBFD. Other Haplohumults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Haplohumults

GBFE. Other Haplohumults that have an ustic moisture regime.

Ustic Haplohumults

GBFF. Other Haplohumults that have a xeric moisture regime.

Xeric Haplohumults

GBFG. Other Haplohumults.

Typic Haplohumults

Kandihumults

Key to subgroups

GBCA. Kandihumults that have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. In one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

Andic Ombroaquic Kandihumults

GBCB. Other Kandihumults that have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. An ustic moisture regime.

Ustandic Kandihumults

GBCC. Other Kandihumults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandihumults

GBCD. Other Kandihumults that have, in one or more subhorizons within the upper 25 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandihumults

GBCE. Other Kandihumults that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

Ombroaquic Kandihumults

GBCF. Other Kandihumults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandihumults

GBCG. Other Kandihumults that have an ustic moisture regime.

Ustic Kandihumults

GBCH. Other Kandihumults that have a xeric moisture regime.

Xeric Kandihumults

GBCI. Other Kandihumults that have an anthropic epipedon.

Anthropic Kandihumults

GBCJ. Other Kandihumults.

Typic Kandihumults

Kanhaplohumults

Key to subgroups

GBDA. Kanhaplohumults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhaplohumults

GBDB. Other Kanhaplohumults that have *both*:

1. An ustic moisture regime; *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Ustandic Kanhaplohumults

GBDC. Other Kanhaplohumults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kanhaplohumults

GBDD. Other Kanhaplohumults that have, in one or more subhorizons within the upper 25 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kanhaplohumults

GBDE. Other Kanhaplohumults that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

Ombroaquic Kanhaplohumults

GBDF. Other Kanhaplohumults that have an ustic moisture regime.

Ustic Kanhaplohumults

GBDG. Other Kanhaplohumults that have a xeric moisture regime.

Xeric Kanhaplohumults

GBDH. Other Kanhaplohumults that have an anthropic epipedon.

Anthropic Kanhaplohumults

GBDI. Other Kanhaplohumults.

Typic Kanhaplohumults

Palehumults

Key to subgroups

GBEA. Palehumults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Palehumults

GBEB. Other Palehumults that have, in one or more subhorizons within the upper 25 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Palehumults

GBEC. Other Palehumults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Palehumults

GBED. Other Palehumults that have an ustic moisture regime.

Ustic Palehumults

GBEE. Other Palehumults that have a xeric moisture regime.

Xeric Palehumults

GBEF. Other Palehumults.

Typic Palehumults

Plinthohumults

Key to subgroups

GBBA. All Plinthohumults (provisionally).

Typic Plinthohumults

Sombrihumults

Key to subgroups

GBAA. All Sombrihumults (provisionally).
Typic Sombrihumults

Udults

Key to great groups

GCA. Udults that have one or more horizons within 150 cm of the mineral soil surface in which plinthite either forms a continuous phase or constitutes one half or more of the volume.
Plinthudults, p. 552

GCB. Other Udults that have a fragipan with its upper boundary within 100 cm of the mineral soil surface.
Fragiudults, p. 537

GCC. Other Udults which:

1. Do not have a densic, lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm; *and*

3. Within 150 cm of the mineral soil surface, *either*:

   a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

   b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.
Kandiudults, p. 541

GCD. Other Udults that have a CEC of 16 cmol(+)/kg clay or less (by 1N NH_4OAc pH 7) and an ECEC of 12 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in 50 percent or more *either* of the argillic or kandic horizon if less than 100 cm thick, *or* of its upper 100 cm.
Kanhapludults, p. 545

GCE. Other Udults which:

1. Do not have a densic, lithic, paralithic, or petroferric contact within 150 cm of the mineral soil surface; *and*

2. Within 150 cm of the mineral soil surface, *either*:

   a. Do not have a clay decrease with increasing depth of 20 percent or more (relative) from the maximum clay content; *or*

   b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.

Paleudults, p. 548

GCF. Other Udults which have *both:*

1. An epipedon that has a color value, moist, of 3 or less throughout; *and*

2. In *all* horizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less; *and*

   c. A value dry no more than 1 unit higher than the value moist.

Rhodudults, p. 552

GCG. Other Udults.

Hapludults, p. 539

Fragiudults

Key to subgroups

GCBA. Fragiudults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Fragiudults

GCBB. Other Fragiudults which have:

1. *Either* of the following:

   a. Above the fragipan, no argillic or kandic horizon that has clay films on both vertical and horizontal surfaces of any structural aggregates; *or*

b. Between the argillic or kandic horizon and the fragipan, one or more horizons with 50 percent or more chroma of 3 or less and with a clay content 3 percent or more (absolute, in the fine-earth fraction) lower than in both the argillic or kandic horizon and the fragipan; *and*

2. In one or more horizons within 40 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage); *and*

3. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthaquic Fragiudults

GCBC. Other Fragiudults that have *both*:

1. *Either* of the following:

a. Above the fragipan, no argillic or kandic horizon that has clay films on both vertical and horizontal surfaces of any structural aggregates; *or*

b. Between the argillic or kandic horizon and the fragipan, one or more horizons with 50 percent or more chroma of 3 or less and with a clay content 3 percent or more (absolute, in the fine-earth fraction) lower than in both the argillic or kandic horizon and the fragipan; *and*

2. In one or more horizons within 40 cm of the mineral soil surface, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Glossaquic Fragiudults

GCBD. Other Fragiudults that have, in one or more subhorizons above the fragipan and within the upper 25 cm of the argillic or kandic horizon, redox depletions with a chroma of 2 or less, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Fragiudults

GCBE. Other Fragiudults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Fragiudults

GCBF. Other Fragiudults that have *either*:

1. Above the fragipan, no argillic or kandic horizon that has clay films on both vertical and horizontal surfaces of any structural aggregates; *or*

2. Between the argillic or kandic horizon and the fragipan, one or more horizons with 50 percent or more chroma of 3 or less and with a clay content 3 percent or more (absolute, in the fine-earth fraction) lower than in both the argillic or kandic horizon and the fragipan.

Glossic Fragiudults

GCBG. Other Fragiudults which have either an Ap horizon, or an A horizon 15 cm or more thick, that has a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample).

Humic Fragiudults

GCBH. Other Fragiudults.

Typic Fragiudults

Hapludults

Key to subgroups

GCGA. Hapludults which have *both*:

1. A lithic contact within 50 cm of the mineral soil surface; *and*

2. In each pedon, a discontinuous argillic horizon that is interrupted by ledges of bedrock.

Lithic Ruptic-Entic Hapludults

GCGB. Other Hapludults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Hapludults

GCGC. Other Hapludults which have *one or both* of the following:

1. Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge-shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface; *or*

2. A linear extensibility of 6.0 cm or more between the mineral soil surface and either a depth of 100 cm or a densic, lithic, or paralithic contact, whichever is shallower.

Vertic Hapludults

GCGD. Other Hapludults that have *both*:

1. Fragic soil properties;

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Fragiaquic Hapludults

GCGE. Other Hapludults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. In one or more subhorizons within the upper 60 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox depletions, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Arenic Hapludults

GCGF. Other Hapludults that have, in one or more subhorizons within the upper 60 cm of the argillic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Hapludults

GCGG. Other Hapludults that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Hapludults

GCGH. Other Hapludults that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Hapludults

GCGI. Other Hapludults have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*

3. In one or more layers *either* within 75 cm of the mineral soil surface *or*, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).
Arenic Plinthaquic Kandiudults

GCCB. Other Kandiudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. In one or more layers *either* within 75 cm of the mineral soil surface *or*, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Arenic Kandiudults

GCCC. Other Kandiudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.
Arenic Plinthic Kandiudults

GCCD. Other Kandiudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 50 to 100 cm; *and*

2. In *all* horizons in the upper 100 cm of the argillic or kandic horizon or throughout the entire argillic or kandic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

a. A hue of 2.5YR or redder; *and*

b. A value moist of 3 or less; *and*

c. A value dry no more than 1 unit higher than the value moist.

Arenic Rhodic Kandiudults

GCCE. Other Kandiudults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 50 to 100 cm.

Arenic Kandiudults

GCCF. Other Kandiudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 100 cm or more; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Grossarenic Plinthic Kandiudults

GCCG. Other Kandiudults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 100 cm or more.

Grossarenic Kandiudults

GCCH. Other Kandiudults that have *both*:

1. An ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Acrudoxic Plinthic Kandiudults

GCCI. Other Kandiudults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acrudoxic Kandiudults

GCCJ. Other Kandiudults that have *both*:

1. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*

2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Kandiudults

GCCK. Other Kandiudults that have *both*:

1. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage); *and*

2. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface *one* or more of the following:

   a. A fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *or*

   b. More than 35 percent (by volume) fragments coarser than 2.0 mm, of which more than 66 percent are cinders, pumice, and pumice-like fragments; *or*

   c. A fine earth fraction containing 30 percent or more particles 0.02 to 2.0 mm in diameter, and

      (1) In the 0.02 to 2.0 fraction, 5 percent or more volcanic glass, and

      (2) [(Aluminum plus 1/2 iron, percent extracted by ammonium oxalate) times 60] plus the volcanic glass (percent) is equal to 30 or more.

Aquandic Kandiudults

GCCL. Other Kandiudults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kandiudults

GCCM. Other Kandiudults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kandiudults

GCCN. Other Kandiudults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kandiudults

GCCO. Other Kandiudults that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

Ombroaquic Kandiudults

GCCP. Other Kandiudults that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Kandiudults

GCCQ. Other Kandiudults that have a sombric horizon within 150 cm of the mineral soil surface.

Sombric Kandiudults

GCCR. Other Kandiudults that have in *all* horizons in the upper 100 cm of the argillic or kandic horizon or throughout the entire argillic or kandic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodic Kandiudults

GCCS. Other Kandiudults.

Typic Kandiudults

Kanhapludults

Key to subgroups

GCDA. Kanhapludults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhapludults

GCDB. Other Kanhapludults that have *both*:

1. Fragic soil properties:

   a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

   b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Fragiaquic Kanhapludults

GCDC. Other Kanhapludults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Kanhapludults

GCDD. Other Kanhapludults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 50 to 100 cm.

Arenic Kanhapludults

GCDE. Other Kanhapludults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acrudoxic Kanhapludults

GCDF. Other Kanhapludults that have *both:*

1. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*

2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less,

accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Kanhapludults

GCDG. Other Kanhapludults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kanhapludults

GCDH. Other Kanhapludults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kanhapludults

GCDI. Other Kanhapludults that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

Ombroaquic Kanhapludults

GCDJ. Other Kanhapludults that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Kanhapludults

GCDK. Other Kanhapludults that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Kanhapludults

GCDL. Other Kanhapludults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kanhapludults

GCDM. Other Kanhapludults that have in *all* horizons in the upper 100 cm of the argillic or kandic horizon or throughout the entire argillic or kandic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

2. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

3. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthaquic Paleudults

GCED. Other Paleudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon that is 50 cm or more below the mineral soil surface; *and*

2. In one or more layers *either* within 75 cm of the mineral soil surface *or*, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Arenic Paleudults

GCEE. Other Paleudults that have *both*:

1. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface; *and*

2. In one or more layers *either* within 75 cm of the mineral soil surface *or*, if the chroma throughout the upper 75 cm results from uncoated sand grains, within the upper 12.5 cm of the argillic or kandic horizon, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Plinthaquic Paleudults

GCEF. Other Paleudults that have *both*:

1. Fragic soil properties;

    a. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

    b. In 60 percent or more of the volume of a layer 15 cm or more thick; *and*

2. In one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Fragiaquic Paleudults

GCEG. Other Paleudults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Paleudults

GCEH. Other Paleudults that have anthraquic conditions.

Anthraquic Paleudults

GCEI. Other Paleudults have an argillic horizon that:

1. Consists entirely of lamellae; *or*

2. Is a combination of two or more lamellae and one or more subhorizons with a thickness of 7.5 to 20 cm, each layer with an overlying eluvial horizon; *or*

3. Consists of one or more subhorizons which are more than 20 cm thick, each with an overlying eluvial horizon, and above these horizons there is either:

   a. Two or more lamellae with a combined thickness of 5 cm or more (that may or may not be part of the argillic horizon); *or*

   b. A combination of lamellae (that may or may not be part of the argillic horizon), and one or more parts of the argillic horizon 7.5 to 20 cm thick, each with an overlying eluvial horizon.

Lamellic Paleudults

GCEJ. Other Paleudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Arenic Plinthic Paleudults

GCEK. Other Paleudults that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Paleudults

GCEL. Other Paleudults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Paleudults

GCEM. Other Paleudults that have fragic soil properties:

1. In 30 percent or more of the volume of a layer 15 cm or more thick that has its upper boundary within 100 cm of the mineral soil surface; *or*

2. In 60 percent or more of the volume of a layer 15 cm or more thick.

Fragic Paleudults

GCEN. Other Paleudults which have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm; *and*

2. In *all* horizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less; *and*

   c. A value dry no more than 1 unit higher than the value moist.

Arenic Rhodic Paleudults

GCEO. Other Paleudults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.

Arenic Paleudults

GCEP. Other Paleudults that have *both*:

1. A sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more; *and*

2. Five percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Grossarenic Plinthic Paleudults

GCEQ. Other Paleudults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 100 cm or more.

Grossarenic Paleudults

GCER. Other Paleudults that have in *all* horizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodic Paleudults

GCES. Other Paleudults.

Typic Paleudults

Plinthudults

Key to subgroups

GCAA. All Plinthudults (provisionally).

Typic Plinthudults

Rhodudults

Key to subgroups

GCFA. Rhodudults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodudults

GCFB. Other Rhodudults that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Rhodudults

GCFC. Other Rhodudults.

Typic Rhodudults

b. Have 5 percent or more (by volume) skeletans on faces of peds in the layer that has a 20 percent lower clay content *and*, below that layer, a clay increase of 3 percent or more (absolute) in the fine-earth fraction.
Paleustults, p. 560

GDE. Other Ustults which have *both*:

1. An epipedon that has a color value, moist, of 3 or less throughout; *and*

2. In *all* horizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

   a. A hue of 2.5YR or redder; *and*

   b. A value moist of 3 or less; *and*

   c. A value dry no more than 1 unit higher than the value moist.

Rhodustults, p. 560

GDF. Other Ustults.
Haplustults, p. 554

Haplustults

Key to subgroups

GDFA. Haplustults that have a lithic contact within 50 cm of the mineral soil surface.
Lithic Haplustults

GDFB. Other Haplustults that have a petroferric contact within 100 cm of the mineral soil surface.
Petroferric Haplustults

GDFC. Other Haplustults that have, in one or more layers both within the upper 12.5 cm of the argillic horizon and within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).
Aquic Haplustults

GDFD. Other Haplustults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic horizon at a depth of 50 to 100 cm.
Arenic Haplustults

GDFE. Other Haplustults that have, in one or more horizons within 75 cm of the mineral soil surface,

1. A thermic, mesic, or colder soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for more than four tenths of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Kandiustults

GDBI. Other Kandiustults which, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some part for 135 cumulative days or less per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Kandiustults

GDBJ. Other Kandiustults that have in *all* horizons in the upper 100 cm of the argillic or kandic horizon or throughout the entire argillic or kandic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodic Kandiustults

GDBK. Other Kandiustults.

Typic Kandiustults

Kanhaplustults

Key to subgroups

GDCA. Kanhaplustults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Kanhaplustults

GDCB. Other Kanhaplustults that have an ECEC of 1.5 cmol(+)/kg clay or less (sum of bases extracted with 1N NH_4OAc pH 7, plus 1N-KCl-extractable Al) in one or more horizons within 150 cm of the mineral soil surface.

Acrustoxic Kanhaplustults

GDCC. Other Kanhaplustults that have, in one or more layers within 75 cm of the mineral soil surface, redox depletions with a color value, moist, of 4 or more and a chroma of 2 or less, accompanied by redox concentrations, and also aquic conditions for some time in most years (or artificial drainage).

Aquic Kanhaplustults

GDCD. Other Kanhaplustults that have a sandy or sandy-skeletal particle-size class throughout a layer extending from the mineral soil surface to the top of an argillic or kandic horizon at a depth of 50 to 100 cm.

Arenic Kanhaplustults

GDCE. Other Kanhaplustults which have *both*:

1. Throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0; *and*

2. When neither irrigated nor fallowed to store moisture, *either*:

   a. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some part for 135 cumulative days or less per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

   b. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udandic Kanhaplustults

GDCF. Other Kanhaplustults that have, throughout one or more horizons with a total thickness of 18 cm or more within 75 cm of the mineral soil surface, a fine-earth fraction with both a bulk density of 1.0 g/cm^3 or less, measured at 33 kPa water retention, and aluminum plus 1/2 iron percentages (by ammonium oxalate) totaling more than 1.0.

Andic Kanhaplustults

GDCG. Other Kanhaplustults that have 5 percent or more (by volume) plinthite in one or more horizons within 150 cm of the mineral soil surface.

Plinthic Kanhaplustults

GDCH. Other Kanhaplustults that have, in one or more horizons within 75 cm of the mineral soil surface, redox concentrations, a color value, moist, of 4 or more, and a hue which is 10YR or yellower, but which becomes redder with increasing depth within 100 cm of the mineral soil surface.

Ombroaquic Kanhaplustults

GDCI. Other Kanhaplustults which, when neither irrigated nor fallowed to store moisture, have *either*:

1. A thermic, mesic, or colder soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is dry in some part for more than four tenths of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, *and* a moisture control section which, in 6 or more out of 10 years, is moist in some or all parts for less than 180 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Aridic Kanhaplustults

GDCJ. Other Kanhaplustults which, when neither irrigated nor fallowed to store moisture, have *either*:

1. A mesic or thermic soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some part for 135 cumulative days or less per year when the temperature at a depth of 50 cm below the soil surface is higher than 5°C; *or*

2. A hyperthermic, an isomesic, or a warmer *iso* soil temperature regime, and a moisture control section which, in 6 or more out of 10 years, is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8°C.

Udic Kanhaplustults

GDCK. Other Kanhaplustults that have in *all* horizons in the upper 100 cm of the argillic or kandic horizon or throughout the entire argillic or kandic horizon, if less than 100 cm thick, more than 50 percent colors that have *all* of the following:

1. A hue of 2.5YR or redder; *and*

2. A value moist of 3 or less; *and*

3. A value dry no more than 1 unit higher than the value moist.

Rhodic Kanhaplustults

GDCL. Other Kanhaplustults.

Typic Kanhaplustults

Paleustults

Key to the subgroups

GDDA. All Paleustults (provisionally).

Typic Paleustults

Plinthustults

Key to subgroups

GDAA. All Plinthustults (provisionally).

Typic Plinthustults

Rhodustults

Key to subgroups

GDEA. Rhodustults that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Rhodustults

GDEB. Other Rhodustults that have a sandy particle-size class throughout the upper 75 cm of the argillic horizon, or throughout the entire argillic horizon if it is less than 75 cm thick.

Psammentic Rhodustults

GDEC. Other Rhodustults.

Typic Rhodustults

Xerults

Key to great groups

GEA. Xerults which:

1. Do not have a densic, lithic, or paralithic contact within 150 cm of the mineral soil surface; *and*

CHAPTER 15

VERTISOLS[1]

Key to suborders

EA. Vertisols which have, in one or more horizons between 40 and 50 cm from the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and one or both* of the following:

1. In more than half of each pedon, either on faces of peds or in the matrix if peds are absent, 50 percent or more chroma of *either*

   a. Two or less if redox concentrations are present; *or*

   b. One or less; *or*

2. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquerts, p. 564

EB. Other Vertisols that have a cryic soil temperature regime.

Cryerts, p 572.

EC. Other Vertisols which, in 6 or more out of 10 years, have *both*:

1. A thermic, mesic, or frigid soil temperature regime; *and*

2. If not irrigated during the year, cracks that remain both:

   a. Five mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*

   b. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

Xererts, p. 585

[1] This chapter on Vertisols was rewritten in 1992 following the recommendations of the International Committee on the Classificaiton of Vertisols (ICOMERT), chaired by Dr. Juan Comerma.

Calciaquerts

Key to subgroups

EADA. Calciaquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or the upper boundary of a duripan if shallower, 50 percent or more colors as follows:

1. A hue of 2.5Y or redder and *either*:

    a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

    b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

Aeric Calciaquerts

EADB. Other Calciaquerts.

Typic Calciaquerts

Duraquerts

Key to subgroups

EABA. Duraquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Duraquerts

EABB. Other Duraquerts which have a thermic, mesic, or frigid soil temperature regime and which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain *both*:

1. Five mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*

2. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

Xeric Duraquerts

EABC. Other Duraquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Duraquerts

EABD. Other Duraquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm or the upper boundary of the duripan if shallower, 50 percent or more colors as follows:

1. A hue of 2.5Y or redder and *either*:

    a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

    b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

Aeric Duraquerts

EABE. Other Duraquerts that have, in one or more horizons within 30 cm of the mineral soil surface, *one or both* of the following in more than half of each pedon:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more.

Chromic Duraquerts

EABF. Other Duraquerts.

Typic Duraquerts

Dystraquerts

Key to subgroups

EAEA. Dystraquerts that have, in one or more horizons within 100 cm of the mineral soil surface, jarosite concentrations and a pH value of 4.0 or less (1:1 water, air-dried slowly in shade).

Sulfaqueptic Dystraquerts

EAEB. Other Dystraquerts that have more than 2.0 cmol(+)/kg Al^{3+} (by 1N KCl) in the fine-earth fraction throughout a layer 10 cm or more thick with an upper boundary between 25 and 50 cm from the mineral soil surface.

Alic Dystraquerts

EAEC. Other Dystraquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.
Aridic Dystraquerts

EAED. Other Dystraquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.
Ustic Dystraquerts

EAEE. Other Dystraquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, 50 percent or more colors as follows:

1. A hue of 2.5Y or redder and *either*:

   a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

   b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

Aeric Dystraquerts

EAEF. Other Dystraquerts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.
Leptic Dystraquerts

EAEG. Other Dystraquerts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.
Entic Dystraquerts

EAEH. Other Dystraquerts that have, in one or more horizons within 30 cm of the mineral soil surface, *one or both* of the following in more than half of each pedon:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more.

Chromic Dystraquerts

EAEI. Other Dystraquerts.

Typic Dystraquerts

Endoaquerts

Key to subgroups

EAGA. Endoaquerts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Endoaquerts

EAGB. Other Endoaquerts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Endoaquerts

EAGC. Other Endoaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Endoaquerts

EAGD. Other Endoaquerts which have a thermic, mesic, or frigid soil temperature regime and which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain *both*:

1. Five mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*

2. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

Xeric Endoaquerts

EAGE. Other Endoaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Endoaquerts

EAGF. Other Endoaquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, 50 percent or more colors as follows:

1. A hue of 2.5Y or redder and *either*:

   a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

   b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

Aeric Endoaquerts

EAGG. Other Endoaquerts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Endoaquerts

EAGH. Other Endoaquerts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Endoaquerts

EAGI. Other Endoaquerts that have, in one or more horizons within 30 cm of the mineral soil surface, *one or both* of the following in more than half of each pedon:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more.

Chromic Endoaquerts

EAGJ. Other Endoaquerts.

Typic Endoaquerts

Epiaquerts

<u>Key to subgroups</u>

EAFA. Epiaquerts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Epiaquerts

EAFB. Other Epiaquerts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Epiaquerts

EAFC. Other Epiaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Epiaquerts

EAFD. Other Epiaquerts which have a thermic, mesic, or frigid soil temperature regime and which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain *both*:

1. Five mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 60 or more consecutive days during the 90 days following the summer solstice; *and*

2. Closed for 60 or more consecutive days during the 90 days following the winter solstice.

Xeric Epiaquerts

EAFE. Other Epiaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.

Ustic Epiaquerts

EAFF. Other Epiaquerts that have, in one or more horizons between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm, 50 percent or more colors as follows:

1. A hue of 2.5Y or redder and *either*:

   a. A color value, moist, of 6 or more and a chroma of 3 or more; *or*

   b. A color value, moist, of 5 or less and a chroma of 2 or more; *or*

2. A hue of 5Y and a chroma of 3 or more; *or*

3. A chroma of 2 or more, and no redox concentrations.

Aeric Epiaquerts

EAFG. Other Epiaquerts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Epiaquerts

EAFH. Other Epiaquerts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.
Entic Epiaquerts

EAFI. Other Epiaquerts that have, in one or more horizons within 30 cm of the mineral soil surface, *one or both* of the following in more than half of each pedon:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more.
Chromic Epiaquerts

EAFJ. Other Epiaquerts.
Typic Epiaquerts

Natraquerts

Key to subgroups

EACA. All Natraquerts.
Typic Natraquerts

Salaquerts

Key to subgroups

EAAA. Salaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.
Aridic Salaquerts

EAAB. Other Salaquerts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 90 or more cumulative days per year.
Ustic Salaquerts

EAAC. Other Salaquerts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.
Leptic Salaquerts

EAAD. Other Salaquerts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.
Entic Salaquerts

EAAE. Other Salaquerts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Salaquerts

EAAF. Other Salaquerts.

Typic Salaquerts

Cryerts

Key to great groups

EBA. Cryerts that have 10 kg/m^2 or more organic carbon between the mineral soil surface and a depth of 50 cm.

Humicryerts, p. 573

EBB. Other Cryerts.

Haplocryerts, p. 572

Haplocryerts

Key to subgroups

EBBA. Haplocryerts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Haplocryerts

EBBB. Other Haplocryerts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Haplocryerts

EBBC. Other Haplocryerts.

Typic Haplocryerts

EDCD. Other Calcitorrerts that have, in one or more horizons within 30 cm of the soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Calcitorrerts

EDCE. Other Calcitorrerts.

Typic Calcitorrerts

Gypsitorrerts

<u>Key to subgroups</u>

EDBA. Gypsitorrerts that have, in one or more horizons within 30 cm of the soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Gypsitorrerts

EDBB. Other Gypsitorrerts.

Typic Gypsitorrerts

Haplotorrerts

<u>Key to subgroups</u>

EDDA. Haplotorrerts that have, throughout a layer 15 cm or more thick within 100 cm of the soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Haplotorrerts

EDDB. Other Haplotorrerts that have, in one or more horizons within 100 cm of the soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Haplotorrerts

EDDC. Other Haplotorrerts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan, within 100 cm of the soil surface.

Leptic Haplotorrerts

EDDD. Other Haplotorrerts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the soil surface.

Entic Haplotorrerts

EDDE. Other Haplotorrerts that have, in one or more horizons within 30 cm of the soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Haplotorrerts

EDDF. Other Haplotorrerts.

Typic Haplotorrerts

Salitorrerts

Key to subgroups

EDAA. Salitorrerts that have, in one or more horizons within 100 cm of the soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Salitorrerts

EDAB. Other Salitorrerts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan or petrocalcic horizon, within 100 cm of the soil surface.

Leptic Salitorrerts

EDAC. Other Salitorrerts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the soil surface.

Entic Salitorrerts

EDAD. Other Salitorrerts that have, in one or more horizons within 30 cm of the soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Salitorrerts

EFAE. Other Dystruderts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Dystruderts

EFAF. Other Dystruderts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Dystruderts

EFAG. Other Dystruderts.

Typic Dystruderts

Hapluderts

Key to subgroups

EFBA. Hapluderts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Hapluderts

EFBB. Other Hapluderts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Hapluderts

EFBC. Other Hapluderts that are saturated with water, in one or more layers within 100 cm of the mineral soil surface, for 1 month or more per year in 6 or more out of 10 years.

Oxyaquic Hapluderts

EFBD. Other Hapluderts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Hapluderts

EFBE. Other Hapluderts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Hapluderts

EFBF. Other Hapluderts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Hapluderts

EFBG. Other Hapluderts.

Typic Hapluderts

Usterts

Key to great groups

EEA. Usterts that have, throughout one or more horizons with a total thickness of 25 cm or more within 50 cm of the mineral soil surface, *both*:

1. An electrical conductivity of the saturation extract of less than 4.0 dS/m at 25°C; *and*

2. A pH value of 4.5 or less in 0.01 M $CaCl_2$ (5.0 or less in 1:1 water).

Dystrusterts, p. 580

EEB. Other Usterts which have a salic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Salusterts, p. 584

EEC. Other Usterts which have a gypsic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Gypsiusterts, p. 581

EED. Other Usterts which have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calciusterts, p. 578

EEE. Other Usterts.

Haplusterts, p. 582

Calciusterts

Key to subgroups

EEDA. Calciusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calciusterts

EEDB. Other Calciusterts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Calciusterts

EEDC. Other Calciusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Calciusterts

EEDD. Other Calciusterts which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calciusterts

EEDE. Other Calciusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Calciusterts

EEDF. Other Calciusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Udic Calciusterts

EEDG. Other Calciusterts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

Leptic Calciusterts

EEDH. Other Calciusterts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Calciusterts

EEDI. Other Calciusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Calciusterts

EEDJ. Other Calciusterts.

Typic Calciusterts

Dystrusterts

Key to subgroups

EEAA. Dystrusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Dystrusterts

EEAB. Other Dystrusterts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Dystrusterts

EEAC. Other Dystrusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Dystrusterts

EEAD. Other Dystrusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days.

Udic Dystrusterts

EEAE. Other Dystrusterts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

Leptic Dystrusterts

EEAF. Other Dystrusterts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Dystrusterts

EEAG. Other Dystrusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Dystrusterts

EECH. Other Gypsiusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Gypsiusterts

EECI. Other Gypsiusterts.

Typic Gypsiusterts

Haplusterts

Key to subgroups

EEEA. Haplusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Haplusterts

EEEB. Other Haplusterts that have, throughout a layer 15 cm or more thick within 100 cm of the mineral soil surface, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Haplusterts

EEEC. Other Haplusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Haplusterts

EEED. Other Haplusterts which have a petrocalcic horizon that has its upper boundary within 150 cm of the mineral soil surface.

Petrocalcic Haplusterts

EEEE. Other Haplusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Haplusterts

EEEF. Other Haplusterts which have *both*:

1. A densic, lithic, or paralithic contact within 100 cm of the mineral soil surface; *and*

2. If not irrigated during the year, cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year

Leptic Udic Haplusterts

EEEG. Other Haplusterts which have *both*:

1. A layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface; *and*

2. If not irrigated during the year, cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year

Entic Udic Haplusterts

EEEH. Other Haplusterts which have *both*:

1. In one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

    a. A color value, moist, of 4 or more; *or*

    b. A color value, dry, of 6 or more; *or*

    c. A chroma of 3 or more; *and*

2. If not irrigated during the year, cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year

Chromic Udic Haplusterts

EEEI. Other Haplusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 150 cumulative days per year.

Udic Haplusterts

EEEJ. Other Haplusterts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan, within 100 cm of the mineral soil surface.

Leptic Haplusterts

EEEK. Other Haplusterts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Haplusterts

EEEL. Other Haplusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Haplusterts

EEEM. Other Haplusterts.

Typic Haplusterts

Salusterts

Key to subgroups

EEBA. Salusterts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Salusterts

EEBB. Other Salusterts that have, in one or more horizons within 100 cm of the mineral soil surface, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Salusterts

EEBC. Other Salusterts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Salusterts

EEBD. Other Salusterts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 210 or more cumulative days per year.

Aridic Salusterts

EEBE. Other Salusterts that have a densic, lithic, or paralithic contact, or the upper boundary of a duripan or petrocalcic horizon, within 100 cm of the mineral soil surface.

Leptic Salusterts

EEBF. Other Salusterts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Salusterts

EEBG. Other Salusterts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Salusterts

EEBH. Other Salusterts.

Typic Salusterts

Xererts

Key to great groups

ECA. Xererts which have a duripan that has its upper boundary within 100 cm of the mineral soil surface.

Durixererts, p. 586

ECB. Other Xererts which have a calcic or petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Calcixererts, p. 585

ECC. Other Xererts.

Haploxererts, p. 587

Calcixererts

Key to subgroups

ECBA. Calcixererts that have a lithic contact within 50 cm of the mineral soil surface.

Lithic Calcixererts

ECBB. Other Calcixererts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for 180 or more consecutive days.

Aridic Calcixererts

ECBC. Other Calcixererts which have a petrocalcic horizon that has its upper boundary within 100 cm of the mineral soil surface.

Petrocalcic Calcixererts

ECBD. Other Calcixererts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Calcixererts

ECBE. Other Calcixererts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Calcixererts

ECBF. Other Calcixererts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Calcixererts

ECBG. Other Calcixererts.

Typic Calcixererts

Durixererts

Key to subgroups

ECAA. Durixererts that have, throughout a layer 15 cm or more thick above the duripan, an electrical conductivity of 15 dS/m or more (1:1 soil:water) for 6 or more months per year in 6 or more out of 10 years.

Halic Durixererts

ECAB. Other Durixererts that have, in one or more horizons above the duripan, an exchangeable sodium percentage of 15 or more (or a sodium adsorption ratio of 13 or more) for 6 or more months per year in 6 or more out of 10 years.

Sodic Durixererts

ECAC. Other Durixererts that have, in one or more horizons above the duripan, aquic conditions for some time in most years (or artificial drainage) *and either*:

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Durixererts

ECAD. Other Durixererts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain 5 mm or more wide, through a

ECCE. Other Haploxererts that have, in one or more horizons within 100 cm of the mineral soil surface, aquic conditions for some time in most years (or artificial drainage) *and either*

1. Redoximorphic features; *or*

2. Enough active ferrous iron to give a positive reaction to a,a'-dipyridyl at a time when the soil is not being irrigated.

Aquic Haploxererts

ECCF. Other Haploxererts which, if not irrigated during the year, have cracks in 6 or more out of 10 years that remain 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the mineral soil surface, for less than 90 consecutive days.

Udic Haploxererts

ECCG. Other Haploxererts that have a densic, lithic, or paralithic contact within 100 cm of the mineral soil surface.

Leptic Haploxererts

ECCH. Other Haploxererts which have a layer 25 cm or more thick that contains less than 27 percent clay in its fine-earth fraction and has its upper boundary within 100 cm of the mineral soil surface.

Entic Haploxererts

ECCI. Other Haploxererts that have, in one or more horizons within 30 cm of the mineral soil surface, 50 percent or more colors as follows:

1. A color value, moist, of 4 or more; *or*

2. A color value, dry, of 6 or more; *or*

3. A chroma of 3 or more.

Chromic Haploxererts

ECCJ. Other Haploxererts.

Typic Haploxererts

CHAPTER 16[1] FAMILY AND SERIES DIFFERENTIAE AND NAMES

It was pointed out earlier that families and series serve purposes that are largely pragmatic, that the series name is abstract, and that the technical family name is descriptive. In this chapter, the descriptive terms used in names of families are defined, the control sections to which the terms apply are given, and the criteria, including the taxa in which they are used are indicated. An example of a family is given to show how the family name is derived, and the differences between the two series in that family are pointed out as examples of series differentiae.

Family differentiae for mineral soils and mineral layers of some organic soils

To distinguish families of mineral soils and mineral layers of some organic soils within a subgroup, the following differentiae are used. The components of the family name are listed and defined in the same sequence in which the components appear in the family names.

- Particle-size classes
- Mineralogy classes
- Cation-exchange activity classes
- Calcareous and reaction classes
- Soil temperature classes
- Soil depth classes
- Rupture resistance classes
- Classes of coatings
- Classes of cracks

Particle-size classes and their substitutes

Definition of particle-size classes and substitutes for classes of mineral soils

The term *particle-size* class is used to characterize the grain-size composition of a whole soil (excluding organic matter and salts more soluble than gypsum), while the term *texture* is used in describing its fine-earth fraction, which consists of particles with a diameter of less than 2.0 mm. Substitutes for particle-size classes are used where normal particle-size classes do not characterize these components adequately.

[1] This chapter on families was rewritten in 1995 following the recommendations of the International Committee on Families (ICOMFAM), chaired by Dr. Ben Hajek.

The particle-size classes of this taxonomy represent a compromise between conventional divisions in pedologic and in engineering classifications. Engineering classifications have set the limit between sand and silt at a diameter of 74 microns, while pedologic classifications have put it at either 50 or 20 microns. Engineering classifications have been based on grain-size percentages by weight in the soil fraction less than 74 mm in diameter, while textural classes in pedologic classifications have been based on percentages by weight in the fraction less than 2.0 mm in diameter. In engineering classifications, the very-fine-sand separate (diameter between 0.05 mm and 0.1 mm) has been subdivided by the 74-micron limit. In defining the particle-size classes for this taxonomy, a similar division has been made, but in a different way. A fine sand or loamy fine sand normally contains an appreciable amount of very fine sand, but the very-fine-sand fraction is mostly coarser than 74 microns. A silty sediment such as loess may also contain an appreciable amount of very fine sand, most of which, however, is finer than 74 microns. So in designing the particle-size classes for this taxonomy, the very fine sand has been allowed to "float." It is included with the sand if the texture (fine-earth fraction) of a soil is sand, loamy fine sand, or coarser. It is, however, treated as silt if the texture is very fine sand, loamy very fine sand, sandy loam, silt loam, or finer.

No single set of particle-size classes seems adequate to serve as family differentiae for all the different kinds of soils. So this taxonomy is providing 2 generalized and 11 more narrowly defined classes, defined later in this chapter. This permits relatively fine distinctions between families of soils for which particle size is important, while providing broader groupings for soils in which narrowly defined particle-size classes would produce undesirable separations. Thus the term clayey is used for some soil families to indicate a clay content of 35 percent (30 percent in Vertisols) or more in specific horizons, while in other families the more narrowly defined terms fine and very fine indicate that these horizons have clay contents either of 35 (30 percent in Vertisols) to 60 percent, or of 60 percent or more, in their fine-earth fraction. The term fine earth refers to particles smaller than 2.0 mm in diameter. The term rock fragments means particles 2.0 mm or more in diameter that are strongly cemented or more resistant to rupture and includes all particles with horizontal dimensions smaller than the size of a pedon. Cemented fragments 2.0 mm or more in diameter that are less strongly cemented are referred to as pararock fragments, and also includes all particles with horizontal dimensions smaller than the size of a pedon. Most pararock fragments are broken into fragments 2.0 mm or less in diameter during the

For example, if a soil meets all of the following: criterion D. (listed below) under the control section for particle-size classes or their substitutes; any Ap horizon is less than 30 cm thick; the weighted average particle-size class of the upper 30 cm of the soil is sandy; the weighted average of the lower part is clayey; and the transition zone is less than 12.5 cm; the family particle-size class of that soil is sandy over clayey. If the particle-size control section includes more than one pair of the strongly contrasting classes, listed below, then the soil is placed in an aniso class named for the pair of adjacent classes that contrast most strongly. The aniso class is considered part of the particle-size class name and is set off by commas after the particle-size name. An example follows: sandy over clayey, aniso, mixed, active Aridic Haplustoll.

Generalized particle-size classes

Two generalized particle-size classes, loamy and clayey, are used with shallow classes (defined below) and soils in arenic, grossarenic, lithic, and pergelic subgroups. The clayey class is used in all strongly contrasting particle-size classes with more than 35 percent clay (30 percent in Vertisols). The loamy particle-size class is used in contrasting classes, where appropriate, to characterize the lower part of the particle-size control section. The generalized classes, where appropriate, are also used for all strongly contrasting particle-size classes that include a substitute class. For example, loamy over pumiceous or cindery (not fine-loamy over pumiceous or cindery) is used.

Six generalized classes, defined later in this chapter, are used in Terric subgroups of Histosols.

Control section for particle-size classes or their substitutes for mineral soils

The particle-size and substitute class names listed below are applied to certain horizons, or to the soil materials within specific depth limits, which have been designated as the particle-size control section. The lower boundary of the control section may be at a specified depth (in centimeters) from the mineral soil surface or the upper boundary of an organic layer with andic soil properties, or at the upper boundary of a root-limiting layer, i.e., a duripan; a fragipan; a petrocalcic, petrogypsic, or placic horizon; continuous ortstein; or at a densic, lithic, paralithic, or petroferric contact. The following list of particle-size control sections for particular kinds of mineral soils is arranged as a key. This key, like others in this taxonomy is designed in such a way that the reader makes the correct classification by going through the key systematically, starting at the beginning and eliminating one by one all classes which include criteria that do not fit the soil in question. The soil belongs to the first class listed for which the soil meets all the criteria listed. The upper boundary of an argillic, natric, or kandic horizon is used in the following key. This boundary is not always obvious. If one of these horizons is present but the upper boundary is irregular or broken, as in an A/B or B/A horizon, consider the depth at which half or more of the volume has the fabric of one of these horizons as the upper boundary.

Key to the control section for particle-size classes or their substitutes of mineral soils

A. For mineral soil soils that have the upper boundary of permafrost or a root limiting layer within 36 cm of the mineral soil surface use 1. or 2. below: *or* other mineral soils go to B. below

1. Permafrost: Between the mineral soil surface and a depth of 36 cm; *or*

2. A root-limiting layer: Between the mineral soil surface and the root-limiting layer.

B. For Andisols: Between either the mineral soil surface or the upper boundary of an organic layer with andic soil properties, whichever is shallower, and the shallowest of the following: (a) a depth of 100 cm, or (b) a root-limiting layer or contact, or (c) a depth of 25 cm below the upper boundary of permafrost. *or*

C. For those Alfisols, Ultisols, and great groups of Aridisols and Mollisols, excluding soils in Lamellic subgroups, which have an argillic, a kandic, or a natric horizon that has its upper boundary within 100 cm of the mineral soil surface and its lower boundary at a depth of 25 cm or more below the mineral soil surface, or which are in a grossarenic or arenic subgroup, use 1. through 4. below: *or* other soils go to D. below

1. Strongly contrasting particle-size classes (defined and listed later) within or below the argillic, kandic, or natric horizon *and* within 100 cm of the mineral soil surface: The upper 50 cm of the argillic, natric, or kandic horizon or to a depth of 100 cm, whichever is deeper, but not below the upper boundary of a contact or root-limiting layer ; *or*

1. Have, in the whole soil, more than 60 percent (by weight) volcanic ash, cinders, lapilli, pumice and pumice-like[2] fragments *and* in the fraction coarser than 2.0 mm, two thirds or more (by volume) pumice and/or pumice-like fragments.
Pumiceous

   or

2. Have, in the whole soil, more than 60 percent (by weight) volcanic ash, cinders, lapilli, pumice and pumice-like fragments *and* in the fraction coarser than 2.0 mm, less than two thirds (by volume) pumice and pumice-like fragments.
Cindery

   or

B. Other mineral soils that meet, in the thickest part of the control section (if the control section is not in one of the strongly contrasting particle-size classes listed below), *or* in part of the control section (if that part qualifies as an element in one of the strongly contrasting particle-size classes listed below), *or* throughout the control section, one of the following sets of substitute class criteria:

1. Have andic soil properties, and a water content at 1500 kPa tension of less than 30 percent on undried samples and less than 12 percent on dried samples; *or*

2. No andic soil properties, and a total of 30 percent or more of the 0.02-to-2.0-mm fraction (by grain count) consisting of volcanic glass, glass aggregates, glass-coated grains, and other vitric volcaniclastics; *and*

   a. A total of 35 percent or more (by volume) rock and pararock fragments, of which two thirds or more (by volume) are pumice or pumice-like fragments.
   Ashy-pumiceous

   or

   b. Have 35 percent or more (by volume) rock fragments.
   Ashy-skeletal

   or

[2] Pumice-like is defined as vesicular pyroclastic materials other than pumice that have an apparent specific gravity (including vesicles) of less than 1.0 g/cm3.

c. Have less than 35 percent (by volume) rock fragments.

Ashy

or

3. Have a fine-earth fraction which has andic soil properties, *and* which has a water content at 1500 kPa tension of 12 percent or more on air-dried samples *or* of 30 to 100 percent on undried samples: *and*

a. Have a total of 35 percent or more (by volume) rock and pararock fragments, of which two thirds or more (by volume) are pumice or pumice-like fragments.

Medial-pumiceous

or

b. Have 35 percent or more (by volume) rock fragments.

Medial-skeletal

or

c. Have less than 35 percent (by volume) rock fragments.

Medial

or

4. Have a fine-earth fraction which has andic soil properties, and which has a water content at 1500 kPa tension of 100 percent or more on undried samples: *and*

a. Have a total of 35 percent or more (by volume) rock and pararock fragments, of which two thirds or more (by volume) are pumice or pumice-like fragments.

Hydrous-pumiceous

or

b. Have 35 percent or more (by volume) rock fragments.

Hydrous-skeletal

or

c. Have less than 35 percent (by volume) rock fragments.

Hydrous

or

C. Other mineral soils that have a particle-size class that has (by weighted average) in the thickest part of the control section (if the control section is not in one of the strongly contrasting particle-size classes listed below), *or* in part of the control section (if that part qualifies as an element in one of the strongly contrasting particle-size classes listed below), *or* throughout the control section, a fine-earth component of less than 10 percent (including associated medium and finer pores) of the total volume.

Fragmental

or

[In the following classes "clay" excludes clay-size carbonates. Carbonates of clay size are treated as silt. If the ratio of percent water retained at 1500 kPa tension to the percentage of measured clay is 0.25 or less or 0.6 or more in half or more of the particle-size control section or part of the particle-size control section in strongly contrasting classes, then the percentage of clay is estimated with the following formula:

Clay % = 2.5(% water retained at 1500 kPa tension - % organic carbon)]

D. Other mineral soils that meet, in the thickest part of the control section, (if part of the control section has a substitute for particle-size class and is not in one of the strongly contrasting particle-size classes listed below), *or* in part of the control section (if that part qualifies as an element in one of the strongly contrasting particle-size classes listed below), *or* throughout the control section meet one of the following sets of particle-size class criteria:

1. Have 35 percent or more (by volume) rock fragments; *and* a fine-earth fraction with a texture of sand or loamy sand, including less than 50 percent (by weight) very fine sand.

   Sandy-skeletal

   or

2. Have 35 percent or more (by volume) rock fragments; *and* less than 35 percent (by weight) clay.

   Loamy-skeletal

   or

3. Have 35 percent or more (by volume) rock fragments.

   Clayey-skeletal

   or

4. Have a texture of sand or loamy sand, including less than 50 percent (by weight) very fine sand in the fine-earth fraction.

   Sandy

   or

5. Have a texture of loamy very fine sand, very fine sand, or a finer texture, including less than 35 percent (by weight) clay in the fine-earth fraction and are in a shallow family (defined below), excluding Vertisols, or in a lithic, arenic, grossarenic, or a pergelic subgroup, or the layer is an element in a strongly contrasting particle-size class (listed below) and the layer is the lower element or the other element is a substitute for particle-size class.
Loamy

or

6. Have in the fraction less than 75 mm in diameter, 15 percent or more (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter); *and* less than 18 percent (by weight) clay in the fine-earth fraction.
Coarse-loamy

or

7. Have in the fraction less than 75 mm in diameter, 15 percent or more (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter); *and* 18 to 35 percent (by weight) clay (Vertisols are excluded).
Fine-loamy

or

8. Have in the fraction less than 75 mm in diameter, less than 15 percent (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter); *and* in the fine-earth fraction, less than 18 percent (by weight) clay.
Coarse-silty

or

9. Have in the fraction less than 75 mm in diameter, less than 15 percent (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter); *and* in the fine-earth fraction, 18 to 35 percent (by weight) clay (Vertisols are excluded).
Fine-silty

or

10. Have 35 percent or more (by weight) clay (more than 30 percent in Vertisols) and are in a shallow family (defined below), or in a lithic,

arenic, grossarenic, or a pergelic subgroup, or the layer is an element in a strongly contrasting particle-size classes (listed below).

Clayey

or

11. Have (by weighted average) less than 60 percent (by weight) clay in the fine-earth fraction.

Fine

or

12. Have 60 percent or more clay.

Very fine

Strongly contrasting particle-size classes

The purpose of strongly contrasting particle-size classes is to identify changes in pore-size distribution or composition, which are not identified in higher soil categories, and which seriously affect the movement and retention of water and/or nutrients.

The following particle-size or substitute classes are considered strongly contrasting if both parts are 12.5 cm or more thick (including parts not in the particle-size control section; however, substitute class names are used only if the soil materials to which they apply extend 10 cm or more into the upper part of the particle-size control section.), and if the transition zone between the two parts of the particle-size control section is less than 12.5 cm thick:

Some classes, such as sandy and sandy-skeletal, have been combined in some places in the following list. In those cases the combined name is used as the family class if part of the control section meets the criteria for either class.

1. Ashy over clayey.
2. Ashy over loamy-skeletal.
3. Ashy over loamy.
4. Ashy over medial-skeletal.
5. Ashy over medial if the water content at 1500 kPa tension in dried samples of the fine-earth fraction is 10 percent or less for the ashy materials and 15 percent or more for the medial materials.
6. Ashy over pumiceous or cindery if there is an absolute difference of 20 percent or more between volumes of rock fragments in the two parts of the control section.
7. Ashy over sandy or sandy-skeletal.
8. Ashy-skeletal over fragmental or cindery if the volume of the fine-earth fraction is 35 percent or more (absolute) greater in the ashy-skeletal part than in the fragmental or cindery part.

9. Cindery over loamy.
10. Cindery over medial-skeletal.
11. Cindery over medial.
12. Clayey over fine-silty if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section.
13. Clayey over fragmental.
14. Clayey over loamy if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section.
15. Clayey over loamy-skeletal if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section.
16. Clayey over sandy or sandy-skeletal.
17. Clayey-skeletal over sandy or sandy-skeletal.
18. Coarse-loamy over clayey.
19. Coarse-loamy over fragmental.
20. Coarse-loamy over sandy or sandy-skeletal if the coarse-loamy material contains less than 50 percent fine or coarser sand.
21. Coarse-silty over clayey.
22. Coarse-silty over sandy or sandy-skeletal.
23. Fine-loamy over clayey if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section.
24. Fine-loamy over fragmental.
25. Fine-loamy over sandy or sandy-skeletal.
26. Fine-silty over clayey if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section.
27. Fine-silty over fragmental.
28. Fine-silty over sandy or sandy-skeletal.
29. Hydrous over clayey-skeletal.
30. Hydrous over clayey.
31. Hydrous over fragmental.
32. Hydrous over loamy-skeletal.
33. Hydrous over loamy.
34. Hydrous over sandy or sandy-skeletal.
35. Loamy over sandy or sandy-skeletal if the loamy material contains less than 50 percent fine or coarser sand.
36. Loamy over pumiceous or cindery.
37. Loamy-skeletal over clayey if there is an absolute difference of 25 percent or more between clay percentages of the fine-earth fraction in the two parts of the control section.
38. Loamy-skeletal over fragmental if the volume of the fine-earth fraction is 35 percent or more (absolute) greater in the loamy-skeletal part than in the fragmental part.

39. Loamy-skeletal over sandy or sandy-skeletalif the loamy material has less than 50 percentfine or coarser sand.
40. Medial over ashy if the water content at 1500 kPa tension in dried samples of the fine-earth fraction is 15 percent or more for the medial materials and 10 percent or less for the ashy materials.
41. Medial over clayey-skeletal.
42. Medial over clayey.
43. Medial over fragmental.
44. Medial over hydrous if the water content at 1500 kPa tension in undried samples of the fine-earth fraction is 75 percent or less for the medial materials.
45. Medial over loamy-skeletal.
46. Medial over loamy.
47. Medial over pumiceous or cindery.
48. Medial over sandy or sandy-skeletal.
49. Medial-skeletal over fragmental or cindery if the volume of the fine earth fraction is 35 percent or more (absolute) greater in the medial-skeletal part than the fragmental or cindery part.
50. Pumiceous or ashy-pumiceous over loamy.
51. Pumiceous or ashy-pumiceous over medial-skeletal.
52. Pumiceous or ashy-pumiceous over medial.
53. Pumiceous or ashy-pumiceous over sandy or sandy-skeletal.
54. Sandy over clayey.
55. Sandy over loamy if the loamy material contains less than 50 percent fine or coarser sand.
56. Sandy-skeletal over loamy if the loamy material contains less than 50 percent fine or coarser sand.

Mineralogy classes

The mineralogy of soil is known to be useful in making predictions of soil behavior and responses to management. Some mineralogy classes occur or are important only in certain taxa or particle-size classes, and others are important in all particle-size classes. The following key to mineralogy classes is designed to make those distinctions.

Control section for mineralogy classes

The control section for mineralogy classes is the same as that defined for the particle-size classes and their substitutes.

Key to mineralogy classes

This key, like the others in Soil Taxonomy, is designed in such a way that the reader makes the correct classification by going through the key systematically, starting at the beginning and eliminating one by one any classes which include criteria that do not fit the soil in question. The soil belongs into the first class listed for which it meets all the required criteria. The user should first check the criteria in section A and, if the soil in question does not meet the criteria listed there, proceed on to sections B, C, D, and E, until the soil meets the criteria listed.
For soils with strongly contrasting particle-size classes, the mineralogy for both named particle-sizes or substitutes are given, unless they are the same. Examples follow: ashy over clayey, mixed (if both the ashy and clayey are mixed), superactive, mesic Typic Vitraquand; clayey over sandy or sandy-skeletal, smectitic over mixed, thermic Vertic Ustochrept.

A. Oxisols and "kandi" and "kanhap" great groups of Alfisols and Ultisols that in the mineralogy control section have (by weighted average):

1. More than 40 percent iron oxide (more than 28 percent Fe by dithionite citrate) in the fine-earth fraction.

   Ferritic

   or

2. More than 40 percent gibbsite in the fine-earth fraction.

   Gibbsitic

   or

3. Both:

   a. 18 to 40 percent iron oxide (12.6 to 28 percent Fe) (by dithionite citrate) in the fine-earth fraction; *and*

   b. 18 to 40 percent gibbsite in the fine-earth fraction.

   Sesquic

   or

4. 18 to 40 percent iron oxide (12.6 to 28 percent Fe) (by dithionite citrate) in the fine-earth fraction.

   Ferruginous

   or

5. 18 to 40 percent gibbsite in the fine-earth fraction.

   Allitic

   or

6. More than 50 percent (by weight) kaolinite in the less than 0.002 fraction.

   Kaolinitic

7. More than 50 percent (by weight) halloysite in the less than 0.002 fraction.

   Halloysitic

   or

8. All other properties.

   Mixed

B. Other soil layers or horizons, in the mineralogy control section, that have a substitute class that replaces the particle-size class and that:

1. Have a sum of eight times the Si (percent by wt. extracted by acid oxalate) plus two times the Fe (percent by wt. extracted by acid oxalate) of 5 or more and eight times the Si is more than two times the Fe.

   Amorphic

   or

2. Other soils that have a sum of eight times the Si (percent by wt. extracted by acid oxalate) plus two times the Fe (percent by wt. extracted by acid oxalate) of 5 or more.

   Ferrihydritic

   or

3. Other soils that have 30 percent or more (by grain count) volcanic glass in the 0.02 to 2.0 mm fraction.

   Glassy

   or

4. All other soils that have modifiers that replace names of particle-size classes.

   Mixed

C. Other mineral soil layers or horizons, in the mineralogy control section, in all other mineral soil orders and in terric subgroups of Histosols that have:

1. Any particle-size class, and more than 40 percent (by weight) carbonates (expressed as $CaCO_3$) plus gypsum, with gypsum constituting more than 35 percent of the total weight of carbonates plus gypsum, either in the fine-earth fraction or in the less-than-20-mm fraction, whichever has a higher percentage of carbonates plus gypsum.

   Gypsic

   or

2. Any particle-size class, and more than 40 percent (by weight) carbonates (expressed as $CaCO_3$) plus gypsum, either in the fine-earth fraction or in the less-than-20-mm fraction, whichever has a higher percentage of carbonates plus gypsum.

Carbonatic

or

3. Any particle-size class, except fragmental, and more than 40 percent (by weight) iron oxide (extractable by dithionite citrate), reported as Fe_2O_3 (or 28 percent reported as Fe), in the fine-earth fraction.

Ferritic

or

4. Any particle-size class, except fragmental, and more than 40 percent (by weight) hydrated aluminum oxides, reported as gibbsite and bohemite, in the fine-earth fraction.

Gibbsitic

or

5. Any particle-size class, except fragmental, and more than 40 percent (by weight) of magnesium-silicate minerals such as the serpentine minerals (antigorite, chrysotile, lizardite) plus talc, olivines, Mg-rich pyroxenes, and Mg-rich amphiboles in the fine-earth fraction.

Magnesic

or

6. Any particle-size class, except fragmental, and in the fine-earth fraction, in more than one half of the thickness, has all of the following:

   a. No free carbonates; *and*

   b. The pH of a suspension of 1 g soil in 50 ml 1 M NaF is more than 8.4 after two minutes; *and*

   c. A ratio of 1500 kPa water to measured clay of more than 0.6; *and*

   d. Does not have *all* of the following:

      (1) 35 percent or more clay; *and*

      (2) More than one half (by weight) halloysite plus kaolinite *and*

(3) More halloysite than any other single mineral in the less-than-0.002-mm fraction.

Isotic

or

7. Any particle-size class, except fragmental, and a total iron oxide, by weight (Fe extracted by citrate-dithionite times 1.43 to report as Fe_2O_3) plus percent (by weight) gibbsite of more than 10 in the fine-earth fraction.

Parasesquic

or

8. Any particle-size class, except fragmental, and more than 20 percent (by weight) glauconitic pellets in the fine-earth fraction.

Glauconitic

or

D. Other mineral soil layers or horizons of soils in all other mineral orders and in terric subgroups of Histosols, in a clayey, clayey-skeletal, fine or very fine particle-size class, that in the less-than-0.002-mm fraction:

1. Have more than one half (by weight) halloysite plus kaolinite and allophane and more halloysite than any other single mineral.

Halloysitic

or

2. Have more than one half (by weight) kaolinite plus halloysite, dickite, and nacrite, and other 1:1 or non-expanding 2:1 layer minerals or gibbsite, and less than 10 percent (by weight) smectite.

Kaolinitic

or

3. Have more (by weight) smectite (montmorillonite, beidellite, and nontronite) than any other single kind of clay mineral.

Smectitic

or

4. Have more than one half (by weight) illite (hydrous mica), and commonly more than 4 percent K_2O.

Illitic

or

5. Have more vermiculite than any other single kind of clay mineral.

Vermiculitic

or

6. All other soils in this category.
Mixed

or

E. All other mineral soil layers that have:

1. More than 40 percent (by weight) mica and stable mica pseudomorphs in the 0.02-to-2.0-mm fraction.
Micaceous

or

2. More than 25 percent (by weight) mica and stable mica pseudomorphs in the 0.02-to-2.0-mm fraction.
Paramicaceous

or

3. More than 90 percent (by weight) silica minerals (quartz, chalcedony, or opal) and other extremely durable minerals that are resistant to weathering, in the 0.02-to-2.0-mm fraction.
Siliceous

or

4. All other properties.
Mixed

Cation-exchange activity classes

The cation-exchange activity classes help in making interpretations of mineral assemblages and of the nutrient holding capacity of soils in mixed and siliceous mineralogy classes of clayey, clayey-skeletal, coarse-loamy, coarse-silty, fine, fine-loamy, fine-silty, loamy, loamy-skeletal, and very fine particle-size classes. Cation exchange activity classes are not used in Histosols and they are not used Oxisols and "kandi" and "kanhap" great groups and subgroups of Alfisols and Ultisols because it would be redundant. Cation-exchange activity classes are not used in sandy, sandy-skeletal, nor the fragmental class because the low clay content causes cation-exchange activity classes to be less useful and less reliable.

The cation-exchange capacity (CEC) is determined by NH_4OAc at pH 7 on the fine-earth fraction and includes the CEC of the organic matter, sand, silt, and clay. The criteria for the classes use ratios of CEC to the percent clay (by weight). (In the following classes "clay" excludes clay-size carbonates.) If the ratio of percent water retained at 1500 kPa tension to the percentage of measured clay is 0.25 or less or 0.6 or more in half or more of the particle-size control section (or part in contrasting families), then the percentage of clay is estimated with the following formula:

D. Other listed soils with a pH is 5.0 or more in 0.01 M $CaCl_2$ (2:1) in some or all layers in the control section.
Nonacid

It should be noted that a soil containing dolomite is calcareous, and that effervescence of dolomite, when treated with cold dilute HCl, is slow.

The calcareous, acid, nonacid, and allic classes are listed in the family name, when appropriate, following the mineralogy class. (NOTE: The rule that required parentheses around the calcareous class when it followed a mineralogy class is discontinued.)

Soil temperature classes

Soil temperature classes, as named and defined here, are used as family differentiae in both mineral and organic soils. The names are used as family modifiers unless the criteria for a higher taxon carry the same limitation. Thus frigid is implied in all boric and cryic suborders and cryic great groups and subgroups, and would be redundant if used in the names of families within these classes of soils.

The Celsius (centigrade) scale is the standard. It is assumed that the temperature is that of a soil that is not being irrigated.

Control section for soil temperature

The control section for soil temperature is either at a depth of 50 cm from the soil surface or at the upper boundary of a root-limiting layer, i.e., a duripan, a fragipan, a petrocalcic, petrogypsic, or placic horizon, or continuous ortstein; or at a densic, lithic, paralithic, or petroferric contact, whichever is shallower. The soil temperature classes, defined in terms of the mean annual soil temperature and difference between mean summer and mean winter temperature, are determined using the following key:

Key to soil temperature classes

A. Soils that have a difference in soil temperature of 5°C or more between mean summer (June, July, and August in the northern hemisphere) and mean winter (December, January, and February in the northern hemisphere) and a mean annual soil temperature of:

1. Lower than 8°C (47°F);
Frigid

or

2. 8° (47°F) to 15°C (59°F);
Mesic
or

3. 15° (59°F) to 22°C (72°F);
Thermic
or

4. 22°C (72°F) or higher.
Hyperthermic

B. All other soil that have mean annual soil temperature, as follows:

1. Lower than 8°C (47°F);
Isofrigid
or

2. 8° (47°F) to 15°C (59°F);
Isomesic
or

3. 15° (59°F) to 22°C (72°F);
Isothermic
or

4. 22°C (72°F) or higher.
Isohyperthermic

Soil depth classes

Distinctions are made to group soils according to soil depth. Soil depth classes are used in all families that have a root limiting layer at the specified depth from the mineral soil surface, except for those families in lithic subgroups and those with a fragipan. The root limiting layers included in depth of soil classes are: duripans; petrocalcic, petrogypsic, and placic horizons; continuous ortstein (90 percent or more); densic, lithic, paralithic, and petroferric contacts. One soil depth class name, shallow, is used to characterize certain mineral soil families that have one of the following depths. Soil depth classes for Histosols are given later in this chapter.

Key to soil depth classes

A. Oxisols that are less than 100 cm deep (from the mineral soil surface) to a root limiting layer, *and* not in a lithic subgroup.
Shallow
or

B. Soils in all other mineral soil orders, less than 50 cm deep (from the mineral soil surface) to a root limiting layer *and* not in a lithic subgroup.
Shallow
or:

C. All other mineral soils.
(No depth of soil class used)

Rupture resistance classes

In this taxonomy, some partially cemented horizons, e.g., durinodes, serve as differentiae in categories above the family, while others, such as partially cemented spodic materials (ortstein), do not. However, no single family should include soils both with and without partially cemented horizons. In Spodosols, a partially cemented spodic horizon is used as family differentia. The following two rupture resistance classes are defined for families of Spodosols:

A. Spodosols that have an ortstein horizon.
Ortstein

or

B. Other Spodosols.
Noncemented

C. All other soils.
(No class rupture resistance Used)

The noncemented class is not used in the name of any family.

Classes of coatings (on sands)

Despite the emphasis given to particle-size classes in the taxonomy, variability remains in the sandy particle-size class, which includes sands and loamy sands. Some sands are very clean, i.e., almost completely free of silt and clay, while others are mixed with appreciable amounts of finer grains. Clay is more efficient at coating sand than is silt. The value of the weighted average silt (by weight) plus two times the weighted average clay (by weight) equal to more than 5 makes a reasonable division of the sands at the family level. Two classes of Quartzipsamments are defined in terms of their silt-plus-two times clay content.

Control section for classes of coatings

The control section for classes of coatings is the same as for particle-size classes or their substitutes and for mineralogy classes.

Family differentiae for Histosols

Most of the differentiae which are used to distinguish families of Histosols have already been defined, either because they are used as differentiae in mineral soils as well as Histosols, or because their definitions are used for the classification of some Histosols in categories higher than the family. In the following, differentiae not previously mentioned are defined and the classes in which they are used are enumerated.

The order in which family classes, if appropriate for a particular family, are placed in the technical family names of Histosols, is as follows:

Particle-size classes
Mineralogy classes, including nature of limnic deposits
Reaction classes
Soil temperature classes
Soil depth classes

Particle-size classes

Particle-size classes are used only for the family names of terric subgroups of Histosols. The classes are determined from the properties of the mineral soil materials in the control section using the key to particle-size classes. The classes used are more generalized than those used for soils in other orders.

Control section for particle-size classes

The particle-size control section is the upper 30 cm of the mineral layer or of that part of the mineral layer that is within the control section for Histosols (given in chapter 3), whichever is thicker.

Key to particle-size classes of Histosols

A. Terric subgroups of Histosols that have (by weighted average) in the particle-size control section:

   1. A fine-earth component of less than 10 percent (including associated medium and finer pores) of the total volume.

      Fragmental

      or

   2. A texture of sand or loamy sand, including less than 50 percent (by weight) very fine sand in the fine-earth fraction.

      Sandy or sandy-skeletal

      or

The ferrihumic mineralogy class is used for families of Fibrists, Hemists, and Saprists, except it is not used in Sphagnofibrists and sphagnic subgroups of other great groups. If the ferrihumic class is used in the family name of a Histosol, no other mineralogy classes are used for that family because the presence of iron is considered to be by far its most important mineralogical characteristic.

Mineralogy classes applied only to limnic subgroups

Limnic materials (defined in chapter 3) with a thickness of 5 cm or more are mineralogy class criteria, if the soil does not also have ferrihumic mineralogy. The following family classes are used: Coprogenous; Diatomaceous; Marly.

The control section for the ferrihumic mineralogy class and mineralogy classes applied to limnic subgroups

The control section for the ferrihumic mineralogy class and the classes applied to limnic subgroups is the same as the control section for Histosols.

Mineralogy classes applied only to terric subgroups

Histosols in terric subgroups, use the same key to mineralogy classes used for mineral soils unless the soil also has ferrihumic mineralogy.

The control section for mineralogy classes applied only to terric subgroups

Terric subgroups of Histosols use the same control section for mineralogy classes, as that used for the particle-size classes.

Key to mineralogy classes

A. Histosols, except folists, Sphagnofibrists, and sphagnic subgroups of other great groups, that have ferrihumic soil material within the control section for Histosols.

Ferrihumic

B. Other Histosols that have within the control section for Histosols limnic materials, 5 cm or more thick, that consist of:

1. Coprogenous earth.

Coprogenous

or

2. Diatomaceous earth.
   Diatomaceous

   or

3. Marl.
   Marly

C. Other Histosols in terric subgroups.
Use **Key to Mineralogy Classes** (for mineral soils).

D. All other Histosols.
No Mineralogy class used.

Reaction classes

Reaction classes are used in all families of Histosols. The two classes recognized are defined in the following key:

A. Histosols that have a pH value, on undried samples, of 4.5 or more (in 0.01 M $CaCl_2$) in one or more layers of organic soil materials within the control section for Histosols.
Euic

or

B. All other Histosols.
Dysic

Soil temperature classes

The soil temperature classes of Histosols are determined using the same key and definitions as those used for mineral soils. The modifier frigid, however, would be redundant in the family names of boric and cryic great groups and cryic and pergelic subgroups and is therefore omitted.

Soil depth classes

Soil depth classes refer to the depth to a root limiting layer, a fragmental particle-size class, or to a cindery, or pumiceous substitute class. The root limiting layers included in depth of soil classes are duripans; petrocalcic, petrogypsic, and placic horizons; continuous ortstein; densic, lithic, paralithic, and petroferric contacts. The following key is used for families in all subgroups of Histosols. The shallow class is not used in the suborder of Folists.

Key to soil depth classes

A. Histosols that are less than 18 cm deep to a root limiting layer, to a fragmental particle-size class, or to a cindery or pumiceous substitute class;
Micro

or

B. Other Histosols, excluding Folists, that have a root limiting layer, a fragmental particle-size class, or a cindery or pumiceous substitute class between 18 and 50 cm from the soil surface;

Shallow

or

C. All other Histosols.

(No soil depth class used)

Series Differentiae Within A Family

The function of the series is pragmatic, and differences within a family that affect the use of a soil should be considered in classifying soil series. The separation of soils at the series level of this taxonomy can be based on any property that is used as criteria at higher levels in the system. Those criteria most commonly used include presence of, depth to, thickness of, and expression of horizons and properties diagnostic for the higher categories and on differences in texture, mineralogy, soil moisture, soil temperature, and amounts of organic matter. The limits of the properties used as differentiae must be more narrowly defined than the limits for the family. However, the properties used must be reliably observable or be inferable from other soil properties or from the setting or the vegetation.

The differentiae used must be within the series control section. Differences in soil or regolith which are outside the series control section and that have not been recognized as series differentiae, but which are relevant to potential uses of certain soils, are considered as a basis for phase distinctions.

Control section for the differentiation of series

The control section for the soil series is similar to those for the family, but it differs in a few important respects. The particle-size and mineralogy control sections for families end at the upper boundary of a fragipan, duripan, or petrocalcic horizon because these horizons contain few roots, and in contrast to the control section for the series, those for the family do not take into account the thickness of such horizons. The series control section includes materials starting at the soil surface and also considers the first 25 cm below a densic and paralithic contact if its upper boundary is less than 125 cm below the mineral soil surface. Properties of horizons and layers below the particle-size control section between 100 and 150 cm (or to 200 cm if in a diagnostic horizon) from the mineral soil surface are also considered.

Key to the control section for the differentiation of series

The part of a soil to be considered in differentiating series within a family is as follows:

A. Mineral soils that have permafrost within 150 cm of the soil surface. From the soil surface to the shallowest of the following:

1. A lithic or petroferric contact; *or*

2. A depth of 100 cm if depth to permafrost is less than 75 cm; *or*

3. 25 cm below the upper boundary of permafrost, if that boundary is 75 cm or more below the soil surface; *or*

4. 25 cm below a densic or paralithic contact; *or*

5. A depth of 150 cm.

B. Other mineral soils, from the soil surface to the shallowest of the following:

1. A lithic or petroferric contact; *or*

2. A depth of either 25 cm below a densic or paralithic contact *or* 150 cm below the soil surface, whichever is shallower, if there is a densic or paralithic contact within 150 cm; *or*

3. A depth of 150 cm if the bottom of the deepest diagnostic horizon is less than 150 cm from the soil surface; *or*

4. The lower boundary of the deepest diagnostic horizon *or* a depth of 200 cm, whichever is shallower, if the lower boundary of the deepest diagnostic horizon is 150 cm or more below the soil surface.

C. Organic soils (Histosols), from the soil surface to the shallowest of the following:

1. A lithic or petroferric contact; *or*

2. A depth of 25 cm below a densic or paralithic contact; *or*

3. A depth of 100 cm if depth to permafrost is less than 75 cm; *or*

4. 25 cm below the upper boundary of permafrost, if that boundary is between 75 and 125 cm below the soil surface; *or*

5. The base of the bottom tier.

Designations for Horizons and Layers

Genetic soil horizons are not the equivalent of the diagnostic horizons of *Soil Taxonomy*. While designations of genetic horizons express a qualitative judgment about the kinds of changes that are believed to have taken place in a soil, diagnostic horizons are quantitatively defined features which are used to differentiate between taxa. A diagnostic horizon may encompass several genetic horizons, and changes implied by genetic horizon designations may not be large enough to justify recognizing different diagnostic horizons. Genetic horizons are designated as follows.

Master Horizons and Layers

The capital letters O, A, E, B, C, and R represent the master horizons and layers of soils. These capital letters are the base symbols to which other characters are added to complete the designations. Most horizons and layers are given a single capital-letter symbol; some require two.

O horizons or layers: Layers dominated by organic material. Some are saturated with water for long periods, or were once saturated but are now artificially drained; others have never been saturated.

Some O layers consist of undecomposed or partially decomposed litter (such as leaves, needles, twigs, moss, and lichens) that has been deposited on the surface; they may be on top of either mineral or organic soils. Other O layers consist of organic material that was deposited under saturated conditions and has decomposed to varying stages. The mineral fraction of such material constitutes only a small percentage of its volume and generally much less than half of its weight. Some soils consist entirely of materials designated as O horizons or layers.

An O layer may be on the surface of a mineral soil, or at any depth below the surface if it is buried. A horizon formed by the illuviation of organic materixl

B horizons: *Horizons which have formed below an A, E, or O horizon; they are dominated by the obliteration of all or much of the original rock structure and show one or more of the following:*

(1) *Illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination;*
(2) *Evidence of removal of carbonates;*
(3) *Residual concentration of sesquioxides;*
(4) *Coatings of sesquioxides that make the horizon conspicuously lower in color value, higher in chroma, or redder in hue, without apparent illuviation of iron, than overlying and underlying horizons;*
(5) *Alteration which forms silicate clay or liberates oxides, or both, and which forms a granular, blocky, or prismatic structure if volume changes accompany changes in moisture content; or*
(6) *Brittleness.*

All the different kinds of B horizons are, or were originally, subsurface horizons. Included as B horizons, where contiguous to other genetic horizons, are layers of illuvial concentration of carbonates, gypsum, or silica which are the result of pedogenic processes (and may or may not be cemented), and brittle layers that show other evidence of alteration, such as prismatic structure or illuvial accumulation of clay.

Examples of layers that are not B horizons are: layers in which clay films either coat rock fragments or cover finely stratified unconsolidated sediments, regardless of whether the films were formed in place or by illuviation; layers into which carbonates have been illuviated but which are not contiguous to an overlying genetic horizon; and layers with gleying but no other pedogenic changes.

C horizons or layers: *Horizons or layers, excluding hard bedrock, that are little affected by pedogenic processes and lack the properties of O, A, E, or B horizons. Most are mineral layers. The material of C layers may be either like or unlike the material from which the solum has presumably formed. The Cfhorizon may have been modified, even if there is no evidence of pedogenesis.*

Included as C layers are sediment, saprolite, unconsolidated bedrock, and other geologic materials which are commonly noncemented and characterized by low or moderate excavation difficulty. Some soils form in material that is already highly weathered, and if such

Single sets of horizon designators do not cover all situations; therefore, some improvising has to be done. For example, Argic Udipsamments have lamellae that are separated from each other by eluvial layers. Because it is generally not practical to describe each lamella and eluvial layer as a separate horizon, the horizons can be combined but the components described separately. One horizon then contains several lamellae and eluvial layers and can be designated an "E and Bt" horizon. The complete horizon sequence for this soil could be: Ap-Bw-E and Bt1-E and Bt2-C.

Suffix Symbols

Lower-case letters are used as suffixes to designate specific kinds of master horizons and layers. The term *accumulation* is used in many of the definitions of such horizons to indicate that these horizons must contain more of the material in question than is presumed to have been present in the parent material. The suffix symbols and their meanings are as follows:

a *Highly decomposed organic material*

This symbol is used with O to indicate the most highly decomposed organic materials, which have a rubbed fiber content of less than 17 percent of the volume.

b *Buried genetic horizon*

This symbol is used in mineral soils to indicate identifiable buried horizons with major genetic features that were developed before burial. Genetic horizons may or may not have formed in the overlying material, which may be either like or unlike the assumed parent material of the buried soil. This symbol is not used in organic soils or to separate an organic from a mineral layer.

c *Concretions or nodules*

This symbol indicates a significant accumulation of concretions or nodules. Cementation is required, but the cementing agent is not specified, except that it cannot be silica. This symbol is not used if the concretions or nodules consist of dolomite or calcite or more soluble salts, but it is used if the nodules or concretions are enriched with minerals that contain iron, aluminum, manganese, or titanium.

combination with s as "Bhs" if the amount of sesquioxide component is significant but the color value and chroma, moist, of the horizon is 3 or less.

i *Slightly decomposed organic material*

This symbol is used with O to indicate the least decomposed of the organic materials. Its rubbed fiber content is 40 percent or more (by volume).

k *Accumulation of carbonates*

This symbol indicates an accumulation of alkaline-earth carbonates, commonly calcium carbonate.

m *Cementation or induration*

This symbol indicates continuous or nearly continuous cementation. It is used only for horizons that are more than 90 percent cemented, although they may be fractured. The cemented layer is physically root-restrictive. The predominant cementing agent (or the two dominant cementing agents) may be indicated by using defined letter suffixes, singly or in pairs. The horizon suffix km indicates cementation by carbonates; qm: cementation by silica; sm: cementation by iron; ym: cementation by gypsum; kqm: cementation by lime and silica; and zm: cementation by salts more soluble than gypsum.

n *Accumulation of sodium*

This symbol indicates an accumulation of ex changeable sodium.

o *Residual accumulation of sesquioxides*

This symbol indicates a residual accumulation of sesquioxides.

p *Tillage or other disturbance*

This symbol indicates a disturbance of the surface layer by mechanical means, pasturing, or similar uses. A disturbed organic horizon is designated Op. A disturbed mineral horizon is designated Ap even though it is clearly a former E, B, or C horizon.

q *Accumulation of silica*

This symbol indicates an accumulation of secondary silica.

r *Weathered or soft bedrock*

This symbol is used with C to indicate root-restrictive layers of saprolite such as weathered igneous rock, or of soft bedrock such as partly consolidated sandstone, siltstone, and shale. Excavation difficulty is low to high.

s *Illuvial accumulation of sesquioxides and organic matter*

This symbol is used with B to indicate an accumulation of illuvial, amorphous, dispersible organic-matter-sesquioxide complexes if both the organic-matter and sesquioxide components are significant, and if the color value and chroma, moist, of the horizon is 4 or more. The symbol is also used in combination with h as "Bhs" if both the organic-matter and sesquioxide components are significant, and if the color value and chroma, moist, is 3 or less.

ss *Presence of slickensides*

This symbol indicates the presence of slickensides. Slickensides result directly from the swelling of clay minerals and shear failure, commonly at angles of 20 to 60 degrees above horizontal. They are indicators that other vertic characteristics, such as wedge-shaped peds and surface cracks, may be present.

t *Accumulation of silicate clay*

This symbol indicates an accumulation of silicate clay that has either formed and subsequently been translocated within the horizon or has been moved into the horizon by illuviation, or both. At least some part of the horizon should show evidence of clay accumulation either as coatings on surfaces of peds or in pores, or as lamellae or as bridges between mineral grains.

v *Plinthite*

This symbol indicates the presence of iron-rich, humus-poor reddish material that is firm or very firm when moist and hardens

vided because of differences in morphological features, the set of Arabic numerals that identifies the additional sampling subdivisions follows the first numeral. For example, three layers of a Bt2 horizon sampled by 10-cm increments are designated Bt21, Bt22, and Bt23. The descriptions for each of these sampling subdivisions can be the same, and a comment can be added stating that the horizon has been subdivided for sampling purposes only.

Discontinuities

In mineral soils, Arabic numerals are used as prefixes to horizon designations (preceding A, E, B, C, and R) to indicate discontinuities. These prefixes are distinct from the Arabic numerals that are used as suffixes to denote vertical subdivisions.

A discontinuity which can be identified by a number prefix is a significant change in particle-size distribution or mineralogy that indicates a difference in the material from which the horizons have formed, and/or a significant difference in age, unless that difference in age is indicated by the suffix b. Symbols to identify discontinuities are used only when they can contribute substantially to an understanding of the relationships among horizons. Stratification common to soils formed in alluvium is not designated as a discontinuity, unless particle-size distribution differs markedly from layer to layer (i.e., particle-size classes are strongly contrasting), even though genetic horizons may have formed in the contrasting layers.

Where a soil has formed entirely in one kind of material, the whole profile is understood to be material 1 and the number prefix is omitted from the symbol. Similarly, the uppermost material in a profile consisting of two or more contrasting materials is understood to be material 1, but the number is omitted. Numbering starts with the second layer of contrasting material, which is designated 2. Underlying contrasting layers are numbered consecutively. Even when the material of a layer below material 2 is similar to material 1, it is designated 3 in the sequence; the numbers indicate a change in materials, not types of material. Where two or more consecutive horizons have formed in the same kind of material, the same prefix number is applied to all the designations of horizons in that material: Ap-E-Bt1-2Bt2-2Bt3-2BC. The suffix numbers designating subdivisions of the Bt horizon continue in consecutive order across the discontinuity.

If an R layer is present below a soil that has formed in residuum, and if the material of the R layer is judged to be like the material from which the soil has developed, the Arabic-number prefix is not used. But the prefix is used if it is thought that the R layer would produce material unlike that in the solum, e.g.: A-Bt-C-2R, or A-Bt-2R. If part of the solum has formed in residuum, the symbol R is given the appropriate prefix: Ap-Bt1-2Bt2-2Bt3-2C1-2C2-2R.

A buried horizon (designated b) presents special problems. It is obviously not in the same deposit as the overlying horizons. Some buried horizons, however, have formed in material which is lithologically like the overlying deposit. A prefix is not used to distinguish material of such a buried horizon. If, however, the material in which a horizon of a buried soil has formed is lithologically unlike the overlying material, the discontinuity is indicated by a number prefix, and the symbol for the buried horizon is used in addition, e.g.: Ap-Bt1-Bt2-BC-C-2ABb-2Btb1-2Btb2-2C.

In organic soils, discontinuities between different kinds of layers are not identified. In most cases such differences are identified either by letter-suffix designations if the different layers are organic, or by the master symbol if the different layers are mineral.

Use of the Prime

If a pedon contains two or more horizons of the same kind which are separated by one or more horizons of a different kind, identical letter and number symbols can be used for those horizons that have the same characteristics. For example, the sequence A-E-Bt-E-Btx-C identifies a soil that has two E horizons. To emphasize this characteristic, the prime (the symbol ') is added after the master-horizon symbol of the lower of the two horizons that have identical designations, e.g.: A-E-Bt-E'-Btx-C. The prime, when appropriate, is applied to the capital-letter horizon designation, and any lower-case letter symbols follow it: B't. It is used only when the letter designations of the two layers in question are completely identical. In the rare cases when three layers have identical letter symbols, a double prime can be used for the lowest of these layers: E''.

The same principle applies in designating layers of organic soils. The prime is used only to distinguish two or more horizons that have identical symbols; e.g., Oi-C-O'i-C' when the soil has two identical Oi layers, or Oi-C-Oe-C' when the two C layers are of the same kind.

SI Unit Conversion Table

CEC and ECEC:

1 meq/100 g soil = 1 cmol(+)/kg soil

Conductivity:

1mmho/cm = 1 dS/m

Pressure:

15-bar water = 1500 kPa water retention

1/3-bar water = 33 kPa water retention

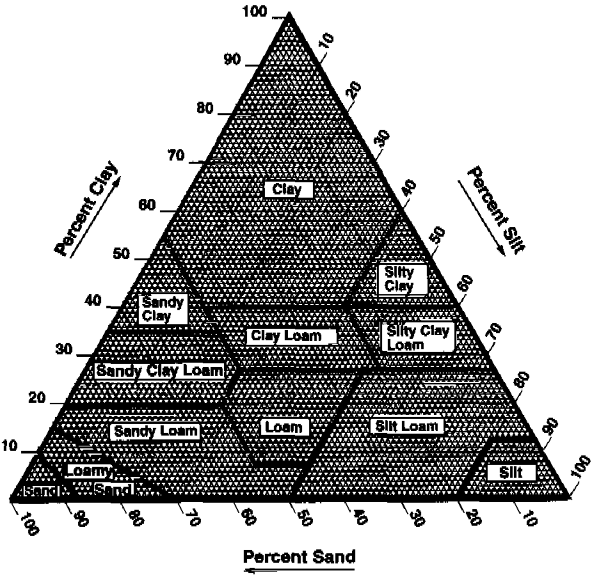

Figure 2 — Chart showing the percentages of clay (below 0.002 mm), silt (0.002 to 0.05 mm), and sand (0.05 to 2.0 mm) in the basic soil textural classes.

Index

B

C

G

H

M

N

O

P

Q

R

S

For sale by the U.S. Government Printing Office
Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9
ISBN 0-16-048848-6